# OPERATING & MAINTENANCE MANUAL

THE MOSELEY

AUTOGRAF

trade mark ®

## MODEL 135 SERIES
## X-Y RECORDER

F. L. MOSELEY CO.
409 NO. FAIR OAKS AVENUE, PASADENA, CALIFORNIA

# OPERATING & MAINTENANCE MANUAL

for

# MODEL 135 SERIES

# X - Y RECORDER

(For Effective Ser. No. See Paragraph 1-3)

(Revised 2-64)

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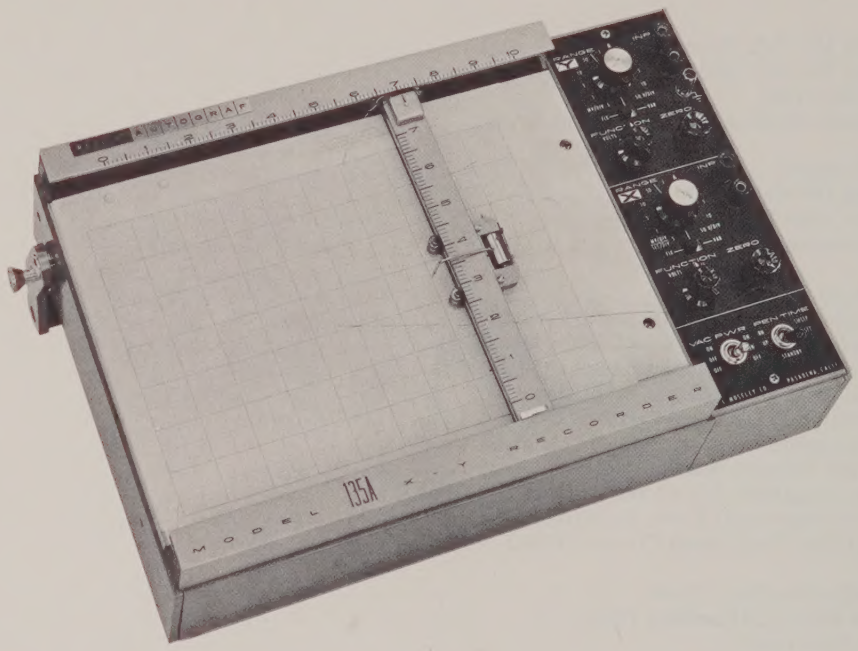



FIGURE 1-1. MODEL 135A X-Y RECORDER

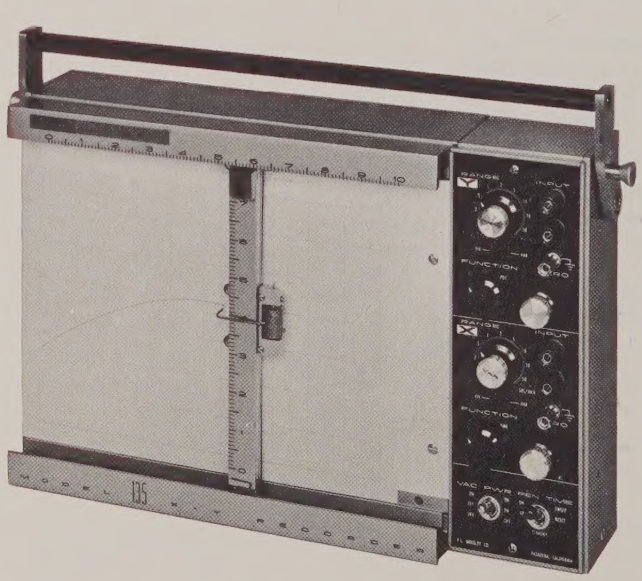



FIGURE 1-2. MODEL 135 X-Y RECORDER

# SECTION I
# GENERAL INFORMATION

## 1-1. DESCRIPTION

1-2. PURPOSE AND CAPABILITY. AUTOGRAF recorders of the Model 135 series are two axis general purpose laboratory instruments basically designed to plot cartesian coordinate curves from DC electrical information. In addition to normal X-Y plotting, a built-in sweep generator provides a time base on the horizontal axis for plotting one variable against time. The recording platen accepts standard graph paper with 7" x 10" (18cm x 25cm) recording area. The instrument is readily adaptable from bench to rack mounting by addition of side brackets, or portable by adding a convenient carrying handle.

## 1-3. MODEL DIFFERENCES

1.4. This manual applies specifically to the Model 135 series recorders beginning with serial No. 551 and the Model 135A series beginning with serial No. 39. The following paragraphs outline variations in features included under specific model designations.

MODEL 135. This is a basic table mounting X-Y recorder. It provides sixteen calibrated DC input ranges, continuous electronic reference, scale factor vernier on all ranges, and will operate with selected standard recorder accessories.

MODEL 135R. This is a rack mounted version of the Model 135, with identical recording capabilities.

MODEL 135M. This unit is identical to the Model 135, but is scaled and calibrated in metric units. Electrical changes are made in the input attenuator to maintain a "1-2-5" sequence in voltage ranges for metric scaling. The Model 135M will also accept the same general accessories as the Model 135, however, metrically calibrated accessories should be utilized wherever possible.

MODEL 135MR. The Model 135MR is a metric version of the rack mounted Model 135R.

MODEL 135A. The Model 135A provides one megohm input resistance at null on a total of eleven fixed input ranges. When using the scale factor vernier, this resistance is maintained on the upper seven range steps but drops to 100,000 ohms on the four lower steps when in the variable mode.

MODEL 135AR. This model is a rack mounting version of the Model 135A.

MODEL 135AM. This version provides the one megohm input resistance feature with metric scaling and calibration. It will accept the same accessories as the Model 135A but metric calibrated accessories are recommended whenever possible.

MODEL 135AMR. This Model provides both one megohm inputs and metric scaling in a rack mounting unit.

## 1-5. ACCESSORY EQUIPMENT AVAILABLE

1-6. While the Model 135 series recorders have many direct uses, their utilization may be increased by the addition of accessory equipment for specialized applications.

1-7. MODEL 60D LOGARITHMIC CONVERTER. This analog device accepts DC or AC input voltages and produces an output DC voltage proportional to the logarithm of the positive peak amplitude of the input voltage. When used in one axis of a recorder, direct plotting may be accomplished on semi-log paper. The converter is also available in a metrically scaled and calibrated version (Model 60DM). Both units are designed for table use or rack mounting.

1-8. TYPE 101 WAVEFORM TRANSLATOR. This unique accessory converts high speed repetitive waveforms as displayed on an oscilloscope to signals which, when applied to a recorder, reproduce the waveform as a permanent, inked record.

1-9. TYPE A-1 AC TO DC CONVERTER. The Type A-1 Converter permits the plotting of AC voltage signals in a frequency range from 20 cycles to 100 kilocycles. Also available is a metrically scaled and calibrated version (Type A-1M). Types A-1R and A-1MR are similar to Types A-1 and A-1M except for rack mounting facilities.

RECORDING MECHANISM:
Independent servo actuated drives for X and Y axes; isolated and free of ground.

PAPER SIZE:
Standard 8-1/2" x 11" graph paper with 7" x 10" recording area. Metric paper has 18 cm x 25 cm recording area.

SLUEING SPEED:
20 inches per second (50 cm/sec) maximum pen speed, each axis.

DC VOLTAGE RANGES (each axis):
Model 135: 16 calibrated ranges: 0.5, 1, 2, 5, 10, 20, and 50 millivolts/division (inch); 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, and 50 volts/division (inch).
Model 135M: 16 calibrated ranges: 0.2, 0.5, 1, 2, 5, 10, 20, 50, and 100 millivolts/centimeter; 0.2, 0.5, 1, 2, 5, 10 and 20 volts/centimeter.
Model 135A (One megohm): 11 calibrated ranges: 0.5, 1, 5, 10, and 50 millivolts/division (inch); 0.1, 0.5, 1, 5, 10, and 50 volts/division (inch).
Model 135AM (One megohm metric): 11 calibrated ranges: 0.2, 0.5, 2, 5, 20, and 50 millivolts/centimeter; 0.2, 0.5, 2, 5, and 20 volts/centimeter.
All Models: Stepless range control permits arbitrary full scale range setting. Potentiometric mode available on most sensitive range position (4 most sensitive ranges on 1 megohm Models) of Y-axis; obtainable on X-axis by removal of strap on input board.

TIME BASE INTERVALS:
Model 135 (standard): 7 calibrated sweeps on X-axis: 0.5, 1, 2, 5, 10, 20, and 50 seconds/division (inch).
Model 135M (metric): 7 calibrated sweeps: 0.2, 0.5, 1, 2, 5, 10, and 20 seconds/centimeter.
Model 135A (one megohm): 5 calibrated sweeps: 0.5, 1, 5, 10, and 50 seconds/division (inch).
Model 135AM (one megohm metric): 5 calibrated sweeps: 0.2, 0.5, 2, 5, and 20 seconds/centimeter.

INPUT RESISTANCE:
Model 135 (standard) 200,000 ohms/volt full scale (10") through 1.0 volt/division (inch) range; 2 megohms on all higher ranges.
Model 135M (metric): 200,000 ohms/volt full scale (25 cms) through 0.5 volt/cm range; 2.5 megohms on all higher ranges.
Models 135A, 135AM (one megohm and one megohm plus metric): one megohm at null on all fixed ranges. When in variable range control mode, 100,000 ohms on four most sensitive range steps and one megohm on all other steps. Potentiometric input draws essentially zero current at null.

ACCURACY:
Better than 0.2% of full scale. Resetability better than 0.1% of full scale. Time base accuracy better than 5% of full scale, adjustable to 1%.

STANDARDIZATION:
Continuous electric reference; zener diode controlled reference voltage supply.

POWER REQUIREMENTS:
115/230 volts, 50/60 cps, approximately 80 volt-amperes.

PHYSICAL DIMENSIONS:
Overall size: 10-1/2" high, 16-1/8" wide, 4-1/2" deep. Weight: Approximately 24 pounds.

FIGURE 1-3. SPECIFICATIONS

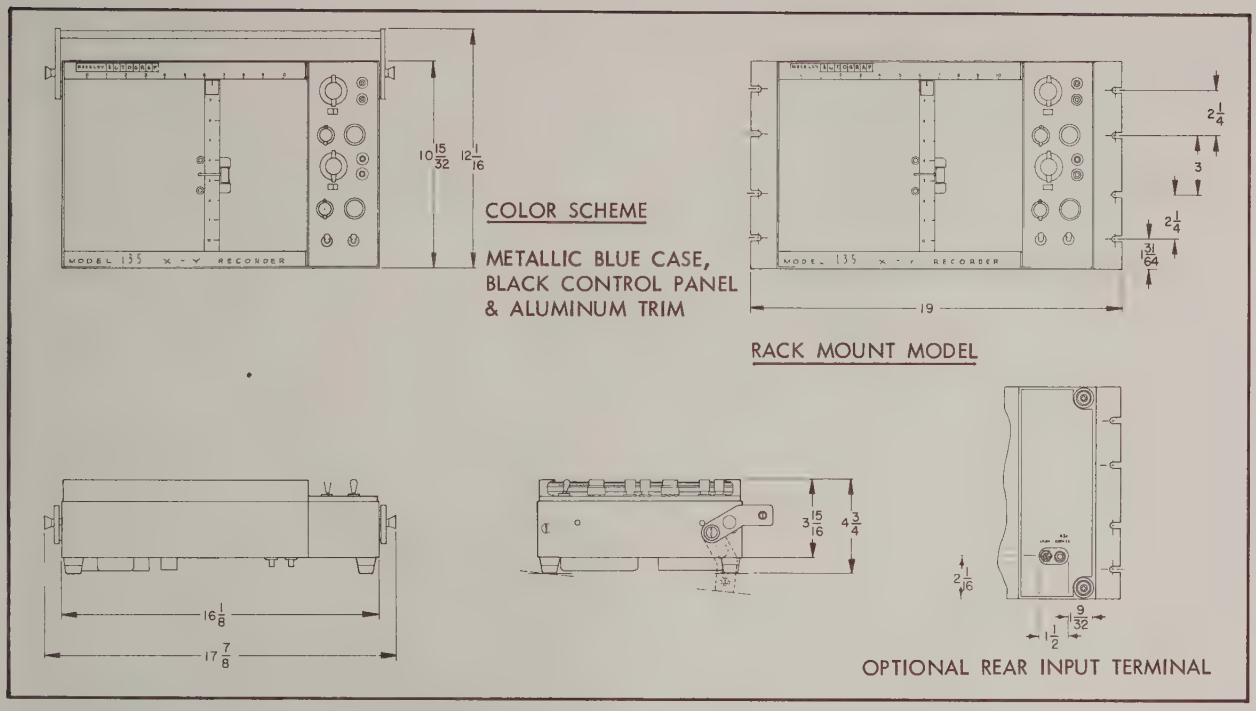



FIGURE 1-4. PHYSICAL DIMENSIONS

# SECTION II
# OPERATION

## 2-1. INTRODUCTION

The basic function of the Model 135 series recorders is to produce graphic tracings showing the relationship between two variable functions. Electrical signals representing these functions are applied to the input terminals of the respective axes and the recorder controls adjusted so that the resulting graph will cover the desired scope of operation. Before operating, the user should become familiar with the input requirements and the various control functions as outlined in the following paragraphs.

## 2-2. ELECTRICAL REQUIREMENTS

2-3. OPERATING POWER. Line power source should be 115 or 230 volts, 50 or 60 cps, single phase. A power conversion switch, located on the rear of the instrument next to the power receptacle, must be set to correspond to the available line voltage.

2-4. INPUT DATA SIGNALS. The recorder input terminals must be supplied with DC signals which are linear (or other desired) functions of the original information. These signals must vary at a rate within the response capabilities of the instrument and have amplitudes within its scale ranges.

CAUTION: Input voltages in excess of 350 volts should not be applied to the Y-axis, nor more than 500 volts to the X-axis.

2-5. GROUNDING. For optimum performance, the third prong of the AC power cord must be grounded. Grounding may also be accomplished by connecting the signal ground terminals (adjacent to the signal input terminals) to ground. Proper grounding has proven to be mandatory when operating from 230 volt power supplies, or from ungrounded power systems.

## 2-6. OPERATING CONTROLS

2-7. VAC PWR SWITCH. A 3-position toggle switch on the lower left of the panel controls power to the instrument.

a. "OFF-OFF". All power to the instrument is turned off.

b. "OFF-ON". All components of the instrument are energized except the vacuum system, servos, and choppers.

c. "ON-ON". All components are energized.

2-8. PEN-TIME SWITCH. A three position lever switch on lower right of the panel with the following functions:

a. "STANDBY". Pen is raised; chopper and motor reference phase are off. This position is used during paper loading.

b. "UP-RESET". Chopper and all other components are energized. Dry runs may be made to adjust range and zero controls. When in TIME mode, pen is returned to zero (or start) position.

c. "DN-SWEEP". Pen is lowered to writing position. Input signals will plot curve. When in TIME mode, sweep action begins.

2-9. Y FUNCTION SWITCH. A three position rotary switch below the Y RANGE control.

a. MV: Selects mv/inch scale on Y RANGE control.

b. VOLTS: Selects volts/inch scale on Y RANGE control.

NOTE: This position does not appear on Model 135A.

INPUT CHART FOR ENGLISH CALIBRATED MODELS (except for one Megohm units)

| Switch Range | Full Scale Input Resistance (ohms/volt) | Full Scale (10") Current Drain (micro-amperes) | Full Scale (10") Input Resistance (ohms) |
|---|---|---|---|
| 0.5 mv/div (inch) | 200,000 | 5 | 1,000 |
| 1 | 200,000 | 5 | 2,000 |
| 2 | 200,000 | 5 | 4,000 |
| 5 | 200,000 | 5 | 10,000 |
| 10 | 200,000 | 5 | 20,000 |
| 20 | 200,000 | 5 | 40,000 |
| 50 | 200,000 | 5 | 100,000 |
| 0.1 v/div (inch) | 200,000 | 5 | 200,000 |
| 0.2 | 200,000 | 5 | 400,000 |
| 0.5 | 200,000 | 5 | 1,000,000 |
| 1 | 200,000 | 5 | 2,000,000 |
| 2 | 100,000 | 10 | 2,000,000 |
| 5 | 40,000 | 25 | 2,000,000 |
| 10 | 20,000 | 50 | 2,000,000 |
| 20 | 10,000 | 100 | 2,000,000 |
| 50 | 4,000 | 250 | 2,000,000 |

INPUT CHART FOR ENGLISH CALIBRATED MODELS (One Megohm units only)

| Switch Range | Full Scale Input Resistance (ohms/volt) | Full Scale (10") Current Drain (micro-amperes) | Full Scale (10") Input Resistance (ohms) |
|---|---|---|---|
| 0.5 mv/dv (inch) | 200,000,000 | 0.005 | 1,000,000 |
| 1 | 100,000,000 | 0.01 | 1,000,000 |
| 5 | 20,000,000 | 0.05 | 1,000,000 |
| 10 | 10,000,000 | 0.1 | 1,000,000 |
| 50 | 2,000,000 | 0.5 | 1,000,000 |
| 0.1 v/div (inch) | 1,000,000 | 1 | 1,000,000 |
| 0.5 | 200,000 | 5 | 1,000,000 |
| 1 | 100,000 | 10 | 1,000,000 |
| 5 | 20,000 | 50 | 1,000,000 |
| 10 | 10,000 | 100 | 1,000,000 |
| 50 | 2,000 | 500 | 1,000,000 |

INPUT CHART FOR METRIC CALIBRATED MODELS (One Megohm units only)

| Switch Range | Full Scale Input Resistance (ohms/volt) | Full Scale (25 cm) Current Drain (micro-amperes) | Full Scale (25 cm) Input Resistance (ohms) |
|---|---|---|---|
| 0.2 mv/cm | 200,000,000 | 0.005 | 1,000,000 |
| 0.5 | 80,000,000 | 0.0125 | 1,000,000 |
| 2 | 20,000,000 | 0.050 | 1,000,000 |
| 5 | 8,000,000 | 0.125 | 1,000,000 |
| 20 | 2,000,000 | 0.500 | 1,000,000 |
| 50 | 800,000 | 1.250 | 1,000,000 |
| 0.2 v/cm | 200,000 | 5.0 | 1,000,000 |
| 0.5 | 80,000 | 12.5 | 1,000,000 |
| 2 | 20,000 | 50.0 | 1,000,000 |
| 5 | 8,000 | 125.0 | 1,000,000 |
| 20 | 2,000 | 500.0 | 1,000,000 |

INPUT CHART FOR METRIC CALIBRATED MODELS (except for one Megohm units)

| Switch Range | Full Scale Input Resistance (ohms/volt) | Full Scale (25 cm) Current Drain (micro-amperes) | Full Scale (25 cm) Input Resistance (ohms) |
|---|---|---|---|
| 0.2 mv/cm | 200,000 | 5 | 1,000 |
| 0.5 | 200,000 | 5 | 2,500 |
| 1 | 200,000 | 5 | 5,000 |
| 2 | 200,000 | 5 | 10,000 |
| 5 | 200,000 | 5 | 25,000 |
| 10 | 200,000 | 5 | 50,000 |
| 20 | 200,000 | 5 | 100,000 |
| 50 | 200,000 | 5 | 250,000 |
| 100 | 200,000 | 5 | 500,000 |
| 0.2 v/cm | 200,000 | 5 | 1,000,000 |
| 0.5 | 200,000 | 5 | 2,500,000 |
| 1 | 100,000 | 10 | 2,500,000 |
| 2 | 50,000 | 20 | 2,500,000 |
| 5 | 20,000 | 50 | 2,500,000 |
| 10 | 10,000 | 100 | 2,500,000 |
| 20 | 5,000 | 200 | 2,500,000 |

FIGURE 2-1. INPUT CHARTS

c. POT: Disconnects range attenuator establishing potentiometric mode with infinite input impedance at null when RANGE switch is set in most sensitive position (0.5 mv/inch or 0.2 mv/cm). On one megohm models, POT establishes potentiometric mode in four most sensitive RANGE positions.

2-10. X FUNCTION SWITCH. A three position rotary switch below the X RANGE control.

a. MV: Selects mv/inch scale on X RANGE control.

NOTE: This position does not appear on Model 135A.

b. VOLTS: Selects volts/inch scale on X RANGE control.

c. TIME: Transfers X-axis into sweep mode with rates as selected on secs/inch scale.

2-11. RANGE SELECTOR. Both stepped and continuously variable controls are provided with scales calibrated in volts/division (inch or centimeter). A slide switch selects either fixed or variable mode. In the "VAR" position, the maximum voltage acceptance of any range setting can be continuously extended to several times its indicated value by adjustment of the top concentric knob on the RANGE selector. This feature may be used to fit experimental data to any portion of the graph.

CAUTION: Input voltage should never exceed 350 volts in the Y-axis or 500 volts in the X-axis. The X-axis RANGE Selector also selects the TIME-SWEEP speeds. Speeds are calibrated in seconds/inch or seconds/centimeter.

2-12. ZERO CONTROLS. Each axis is equipped with a ZERO control providing both fine and coarse adjustment (135A provides a single adjustment) of the electrical zero anywhere on the paper and up to one full scale length to the left and below the normal zero position regardless of the RANGE settings. The VOLTS/DIVISION calibration is not affected.

NOTE: To prevent strain on the servo drives, the zero scale offset should be employed only to counteract a steady-state input which drives the pen toward full scale, or to reposition the minimum point at scale zero. It should not be used to establish the minimum point effectively off the paper, as this will cause the servo drives to exert continuous force against the stop mechanisms.

2-13. INPUT TERMINALS. Three connections are provided for the Y-axis, one grounding and two polarized. Two polarized terminals are used on the X-axis. Terminals will accept either open wire or banana plug connectors.

## 2-14. OPERATING PROCEDURE

2-15. CONDITIONS OF OPERATION. For satisfactory operation the applied input signal must be DC, the available voltage being a linear function of the original information. Amplitudes of the signal must be within the scale RANGE and vary in level within the response capabilities of the instrument.

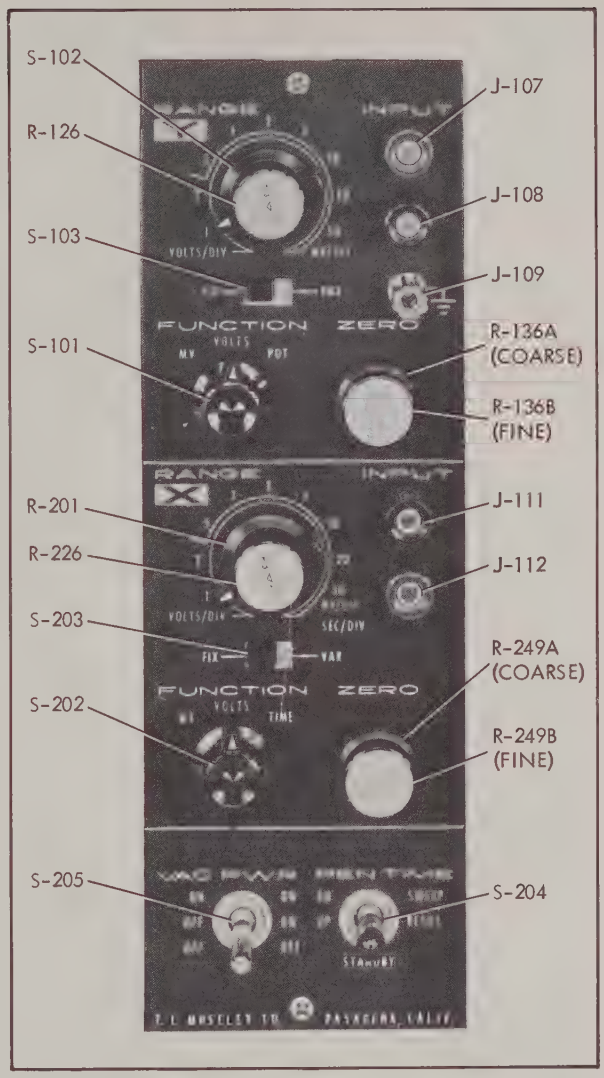



FIGURE 2-2. MODEL 135 CONTROL PANEL

2-16. OPERATION. Providing the input conditions are satisfied, the recorder may be placed into operation as follows:

a. Preset the power conversion switch on rear of instrument to available line voltage (115 or 230 volts). Place the "VAC-PWR" switch in the "OFF-ON" position.

b. Using a hypodermic syringe, fill ink reservoir just short of full. Force ink into the pen tip by inserting an empty syringe into the filler opening and squeeze gently.

c. Load paper as follows:

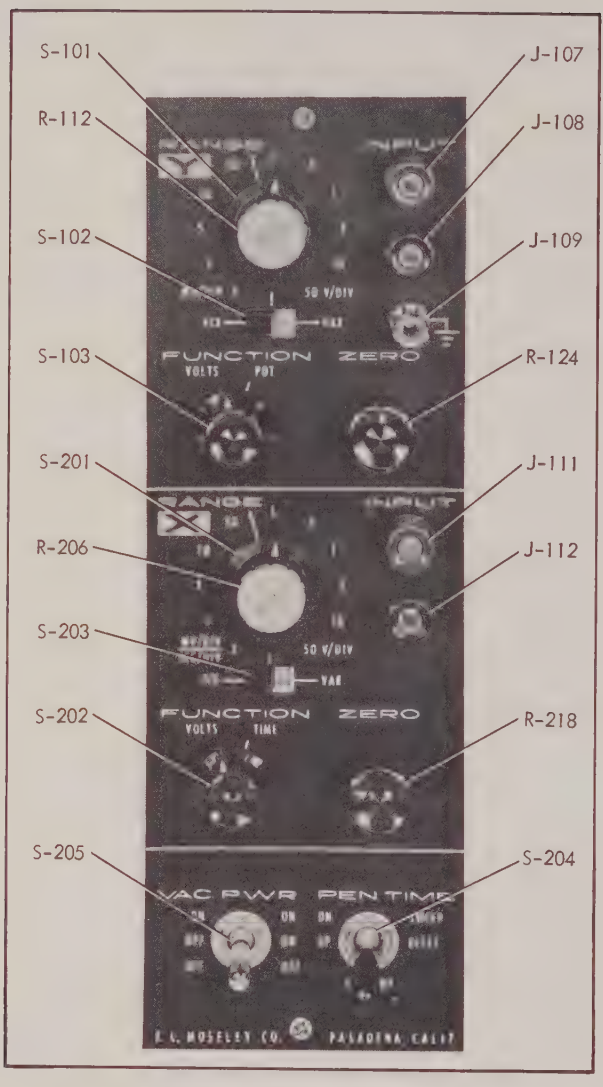



FIGURE 2-3. MODEL 135A CONTROL PANEL

(1) Set the VAC-PWR switch to "OFF-ON" and PEN-TIME switch to "STANDBY."

(2) Install a sheet of graph paper on the recording platen, aligning lower left edges with corresponding table guides.

(3) Set the VAC-PWR switch to "ON-ON" thereby activating the vacuum system. Adjust and smooth paper as necessary.

(4) Set the PEN-TIME switch to "UP-RESET."

d. Connect signal voltages to be recorded to input terminals and set RANGE to the expected maximum values.

e. To establish accurate zero offset, connect a desired offset voltage to that axis and adjust the ZERO control to bring the carriage or pen index into exact agreement with the "O" mark on the corresponding scale.

f. Data may now be "dry" run to insure adequate range and desired positioning of recording on the paper. To record, set PEN-TIME switch to DN-SWEEP.

2-17. TIME BASE OPERATION. The Model 135 series is equipped with a time base on the X-axis only. To record a variable function versus time, proceed as follows:

a. Prepare recorder and load paper as described in paragraph 2-15.

b. Set the X-axis FUNCTION switch to "TIME."

c. Select the desired time sweep rate on the X RANGE switch.

d. Introduce signal to be recorded into Y input terminals.

e. Place the PEN-TIME switch to "DN-SWEEP." Pen will move along X-axis at rate selected and plot the Y signal against time.

f. To raise pen and return it to the starting position, move the PEN-TIME switch to "UP-RESET."

2-18. REMOTE CONTROL OF PEN-LIFT. When operating with accessory equipment it is often desirable to actuate the pen-lift mechanism from an external control. For convenience in this type of operation, a jack marked REMOTE-PEN is provided on the rear of the instrument. A contact closure applied to this jack will cause the pen to lower and remain down for the duration of recording.

2-19. PEN ASSEMBLY. The assembly consists of a drum type reservoir resting in a pivot mount which moves along the carriage beam. A rigid capillary tube feed line leads from the reservoir to the pen point. The pen is raised and lowered by a lever system operated by an electromagnet.

## 2-20. OPERATING PRECAUTIONS

2-21. The VAC-PWR switch position applies 115 volts to the fixed phase windings of the two drive motors and the vacuum pump motor. Simultaneously, 6.3 volts is applied to the chopper. To lower power dissipation and avoid unnecessary wear to the balancing potentiometers, vacuum pump, and other mechanical parts when not actually recording, the VAC-PWR switch should be set to OFF-ON and the PEN-TIME switch to STANDBY.

2-22. When a voltage in excess of the RANGE setting is applied to either set of input terminals, the pen carriage or pen beam (depending upon the axis used) will be driven rapidly to full scale and strike the stops. If this condition prevails for any length of time, the high voltage may cause component failure. The motor will continue running due to a slip-clutch arrangement, resulting in motor overheating and excessive clutch wear.

2-23. Operation of the one megohm models on the most sensitive input ranges from a very low impedance source such as battery or thermocouple voltages

may require a reduction in gain to prevent instability. Refer to paragraph 4-10 for gain adjustment procedures.

2-24. Operation of the one megohm models on the most sensitive input ranges with no input will result in relatively little or no "null". This can be overcome by shunting the input terminals with a 10K resistor which should be removed when reapplying a signal.

2-25. TYPICAL RECORDING PERFORMANCE. Figure 2-4 shows typical performance on a normal production recorder. Lines 2, 3, and 4 were drawn by using a hand operated signal source similar to the test generator, figure 4-3. Curves 1 and 5 were produced by recording current vs voltage of a type 1N34 diode. All recordings of figure 2-4 show "original trace" and "retrace" characteristics, clearly illustrating any servo dead zones or lag.

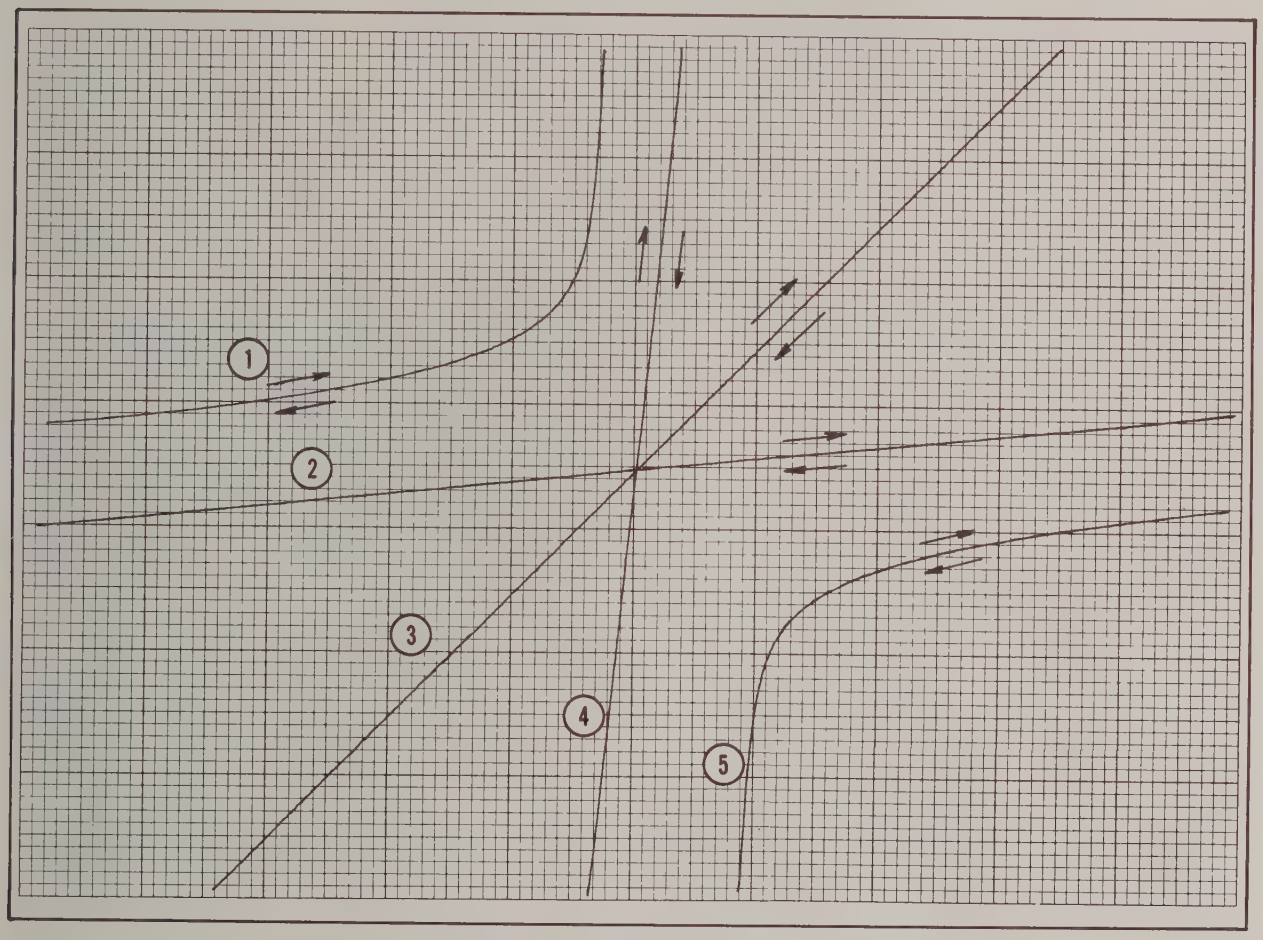



FIGURE 2-4. PERFORMANCE CURVES

# SECTION III

# PRINCIPLES OF OPERATION

## 3-1. GENERAL OPERATION DESCRIPTION

3-2. SERVO MECHANISM. Model 135 series are equipped with two similar but independent self-balancing servo-mechanisms, isolated from ground. In operation, one servo-mechanism moves the recording pen in a vertical direction, and the other moves the entire carriage arm in a horizontal direction in response to input signals representing data applied to the respective input terminals. The resulting relative motion of the two servo-mechanisms trace cartesian coordinate graphs of the relationship on the paper.

3-3. EXPANDABLE RANGE SELECTORS. The basic voltage range of the servo systems is 0 to 3.5 millivolts DC for the Y-axis, and 0 to 5.0 millivolts DC for the X-axis for full scale pen travel. Operation with greater voltages is obtained by means of a step attenuator inserted between the input terminals and the balance circuit. Each range step may be made continuously variable by operation of a transfer switch which inserts a variable potentiometer into the attenuator circuit. Adjustment of this potentiometer increases the range span selected by the range switch so that an arbitrary voltage may drive the recorder to full scale in either axis. The range setting should be such that the amplitude of the input data will be within the travel limits of the instrument. Except in one megohm models, the input circuit includes a filter which minimizes undesirable noise and ripple disturbances in the input signals.

3-4. CIRCUITRY DIFFERENCES BETWEEN MODELS. Because of major differences, circuit descriptions of Models 135 and 135A are described separately. Model 135 is covered by paragraphs 3-5 through 3-19; and Model 135A, by paragraphs 3-20 through 3-33.

## 3-5. CIRCUIT DESCRIPTION OF THE 135 SERIES

3-6. POTENTIOMETRIC INPUT. For maximum sensitivity with minimum current drain from the signal source, all Model 135 series recorders may be converted for potentiometric input. This is accomplished in the Y-axis by setting the FUNCTION switch to "POT" and in the X-axis by removing a bus strap on the input circuit board. Location of this wire is shown in Fig. 3-1. Full scale deflection is then obtained on the 0.5 mv/div (0.2 mv/cm) ranges with inputs of 3.5 and 5 millivolts on the Y and X axes, respectively. When operating in this mode, the source impedance must be kept to 1500 ohms or less.

3-7. INPUT ATTENUATOR. Input terminals of each axis connect to a precision step attenuator which determines the maximum allowable input voltage. The resistors forming the Y-axis attenuator are R-101 through R-122 (R-111 and R-112 not used); the X-axis, R-201 through R-222 (R-211 and R-212 are not used). The attenuator consists of 20 precision (±.1%) wirewound resistors in each axis. With the selector switch in the 0.5 mv/division (inch) or 0.2 mv/cm position, the input voltages are applied across 1000 ohms and go directly to the balance circuit with no attenuation. The full scale balance voltage is always 3.5 mv for the Y-axis and 5 mv for the X-axis. For higher ranges, resistance is inserted in series with the 1000 ohms. Above the 1 volt per division (inch) or one volt/cm scale the 1000 ohms is shunted and no additional series resistance is added.

3-8. VARIABLE RANGE CIRCUITS. When the FIX-VAR switches S-103 and S-203 are in the VAR position input voltages are switched through the variable range extender circuits. When in the FIX position, the 1000 ohm resistors R-123 (Y-axis) and R-221 (X-axis) are connected to the calibrated circuit and input voltages by-pass the variable range extender circuits. A constant impedance potentiometer is used to extend the range. The Y-axis components are potentiometer R-126, and fixed resistors R-124 and R-125; in the X-axis, potentiometer R-226 and fixed resistors R-224 and R-226.

3-9. INPUT FILTER. The input filter is composed of three RC sections. It is a low pass filter providing

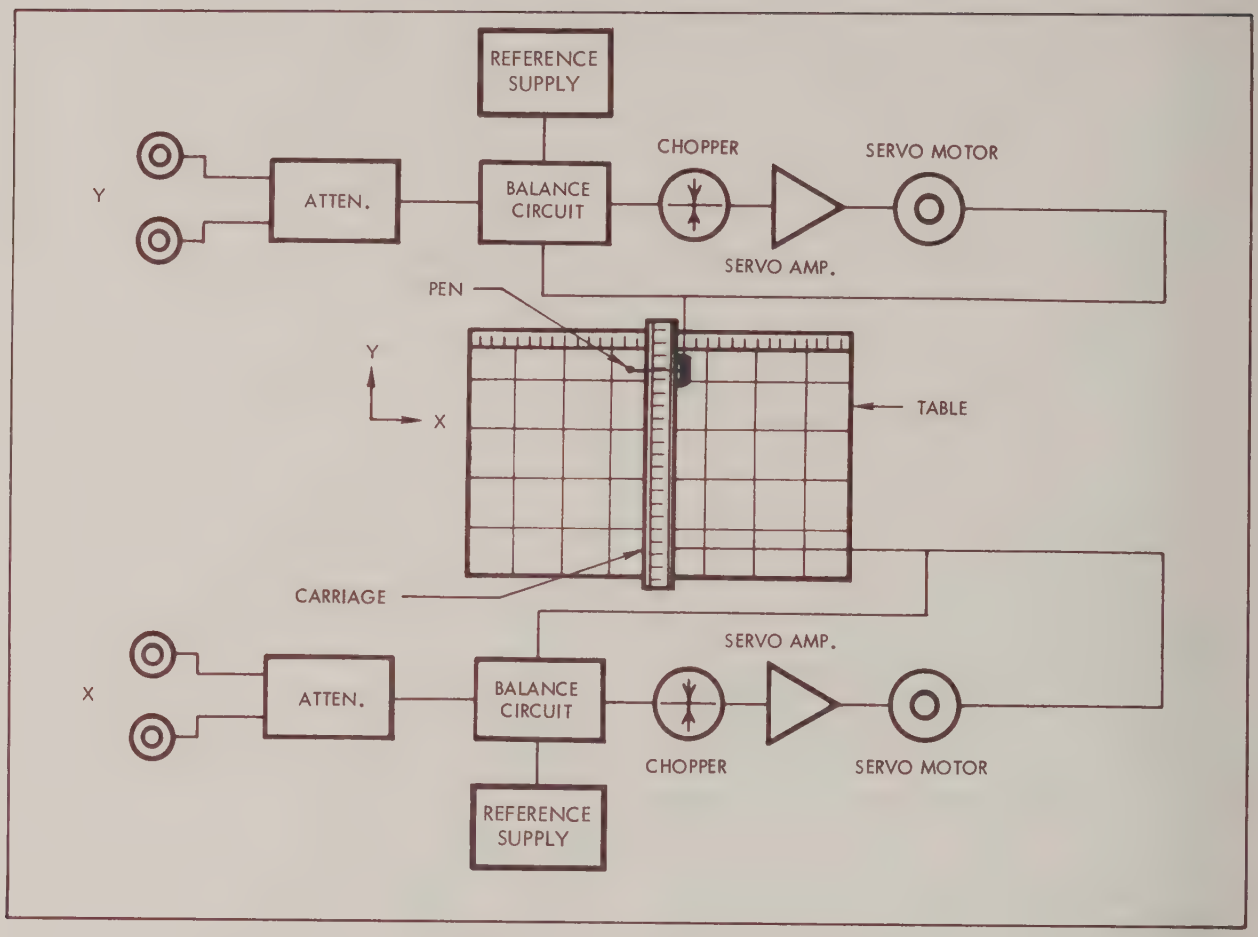



FIGURE 3-1. BLOCK DIAGRAM

about 26 db attenuation at 60 cycles and rapid cut-off at higher frequencies to insure smooth plotting from signals containing extraneous noise. Filter components in the X-axis are capacitors C-201, C-202, and C-203 with resistors R-227, R-228 and R-229; in the Y-axis capacitors C-101, C-102, and C-103, with resistors, R-127, R-128 and R-129.

3-10. REFERENCE SUPPLY. The reference voltage for each axis is independently derived from a Zener controlled DC power supply, nominally 6 volts, stable to ±0.03% with a line variation of ±10%. The primary of transformer T-501 is supplied with 115 VAC. The rectified output from diodes CR-503 and CR-504, filtered by capacitor C-501 and resistor R-502, is applied to Zener diode CR-502 which has high regulating ability. This diode is used to reduce the line voltage variation which may appear in the rectified output. CR-501 is a zero temperature coefficient Zener diode which further regulates the output of the previous stage for greater precision. This diode is operated at current and voltage levels to provide temperature compensation for the reference supply. Calibrate rheostats R-138 (in Y) and R-253 (in X) are adjusted to produce full scale balance with 5 mv in X and 3.5 mv in Y.

3-11. BALANCE CIRCUIT. After passing through the input attenuator and filter circuit, the DC input signal is applied to the balance circuit where it is opposed by a DC cancellation voltage from the internal reference supply. The difference between these two voltages (error signal) is applied to the servo amplifiers which drive the servo motors. The re-balance potentiometers R-139 (Y-axis) and R-256 (X-axis), being mechanically coupled to the servos, are driven in a direction to cancel the error signal produced by the input voltage. Dual potentiometers R-136A, B and R-249A, B provide course and fine ZERO control for the Y and X axes, respectively. These potentiometers introduce into the balance circuit a controlled error signal which is cancelled in the same manner as a regular input error signal. This provides a means for placing zero anywhere within the graph limits. Certain resistors in the balance circuit do not have the same value in each axis, such as balance potentiometers R-139 and R-256. This inequality is necessary to equalize the sensitivity of the two channels in millivolts per inch. Selection of resistance values is governed by the requirement that the potentiometer must impose minimum drain on the reference supply, yet be low in value compared to the rebalance

potentiometers so that loading and nonlinearity will be held within the accuracy limits of the instrument. In addition, the DC attenuation provided by R-244 and R-133 serves the beneficial purpose of reducing potentiometer noise. This noise is predominantly the result of imperfect contact of the wiper on the resistance element causing a saw-tooth component of noise voltage, and a tribolectric DC voltage which is generated by friction of dissimilar metals.

3-12. DAMPING. Capacitor C-104 (in Y) and C-207 (in X) draw a charging current whenever a change in input occurs, thus increasing the rate of appearance of the balance voltage across R-131 and R-243. This phase advance in the slowly varying error signal causes an "anticipatory" approach to the balance point, producing damping.

3-13. CHOPPER AND INPUT TRANSFORMER. The DC difference between the input signal and the rebalance voltage (error signal) is converted to 60 cps AC (or 50 cps depending upon the power frequency) by the chopper. As the chopper is driven in synchronism with the power line, the AC error signal output from the transformer will be either in phase or 180 degrees out with respect to the line, disregarding chopper lag, depending on the polarity of the DC error signal. The direction of rotation of the servo motor is determined by the relative phase excitation of its two windings and this phase-sensing causes the motor to drive the pen carriage (coupled to the rebalance potentiometer) in the proper direction to seek balance. A voltage gain of about 13 is realized in the transformer T-301. The total magnitude of the error signal never exceeds 3.5 or 5 mv, and as the instrument must be sensitive to approximately 0.1% of this voltage, it is apparent that the error signals present are exceedingly small, actually in microvolts. All input circuitry is carefully designed to minimize interference from stray hum pickup and thermal EMF's.

3-14. VOLTAGE AMPLIFIER STAGE. The first stage of amplification is provided by Nuvistor triode V-301. This vacuum tube provides the amplifier with low noise and high input impedance.

3-15. PHASE INVERTER. The function of the phase inverter is to provide amplification and phase inversion between the incoming signal and the voltage amplifier. The first amplifier stage is capacitor coupled to the phase inverter by capacitor C-303. Phase inversion is accomplished by applying a decreasing voltage to the base of transistor TR-301. This causes a rising voltage at the collector while the emitter voltage decreases in trying to follow the base. The base of transistor TR-302 is AC grounded through capacitor C-304 and resistor R-305. The effect of the decreasing emitter signal on TR-301 is a rising signal at the collector of TR-302.

3-16. POWER AMPLIFIER STAGES. In a conventional circuit, two pair of transistors operate in phase opposition. The first stage consists of transistors TR-303 and TR-304, the second stage, TR-305 and TR-306. The phase inverter is coupled to the first push-pull stage by capacitors C-306 and C-307. The first and second stages are coupled by capacitors

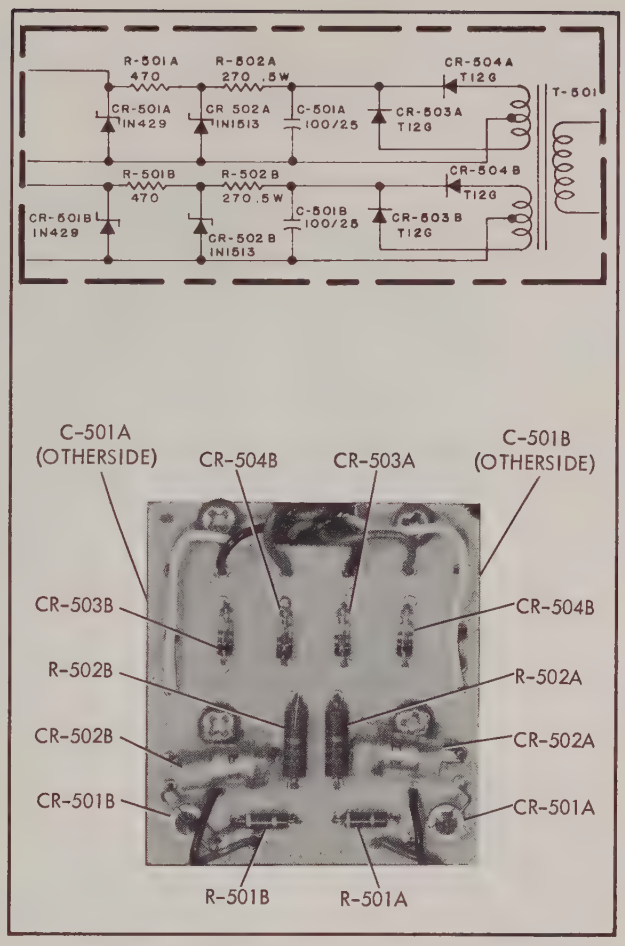



FIGURE 3-2. REFERENCE SUPPLY BOARD AND SCHEMATIC

C-308 and C-309. The push-pull amplifier drives the output power transistors TR-307 and TR-308 through transformer T-302. These transistors supply operating power to the servo motors. Gain control is provided by potentiometer R-311. A change in setting of R-311 varies the amount of negative feedback, thereby changing the total gain. The major feedback loop is composed of resistors R-321 and R-323 and capacitors C-311 and C-312. Sufficient phase change is introduced through the amplifier so that when the phase lag of the chopper is added, the output control voltage to the servo motor is approximately 90° out of phase with the reference winding of that motor.

3-17. MOTOR AND MECHANICAL DAMPER. The servo motor is a Moseley 3 watt, 2 phase induction motor, one phase of which is energized from the AC line, the other being excited in phase quadrature from the amplifier output. Direction of motor rotation is determined by a leading or lagging 90° relationship. A pinion on the motor shaft meshes with an aluminum gear which is geared to a sheave by means of a friction clutch. This drives the pen or carriage by means of cables, translating angular displacement of the shaft into linear motion of the pen or carriage. On

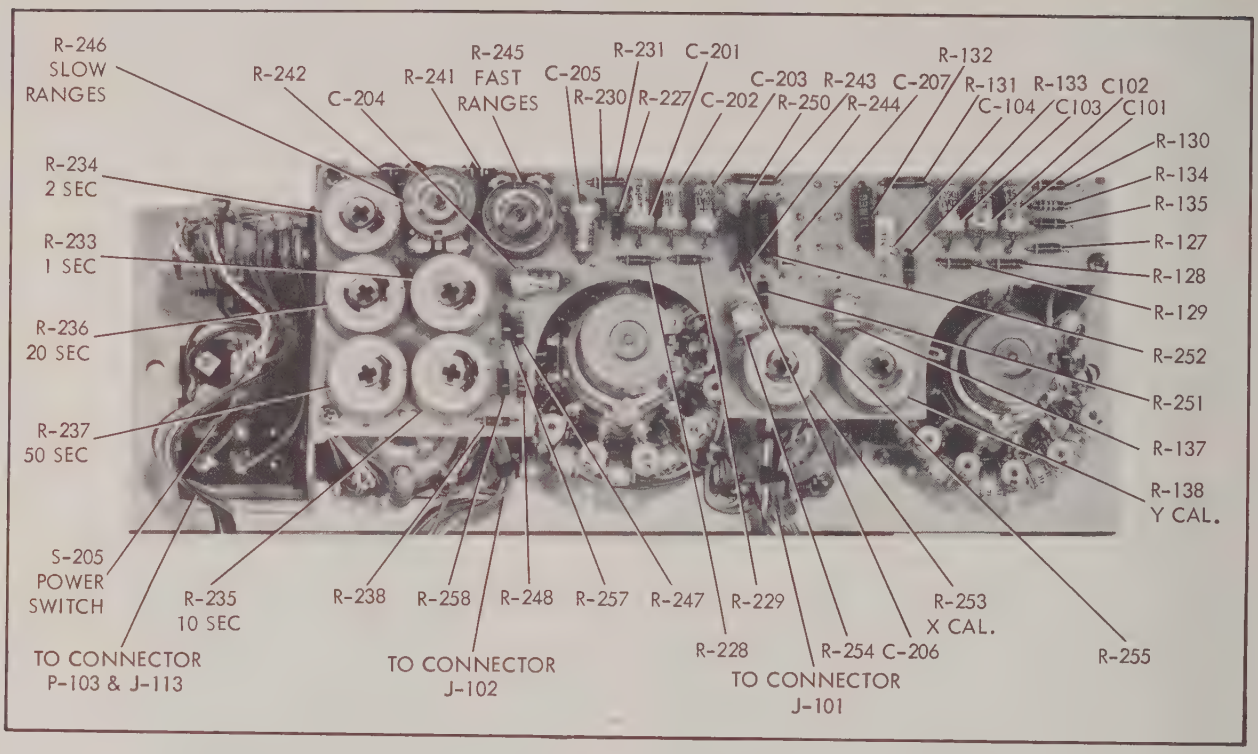



FIGURE 3-3. BALANCE CIRCUIT BOARD AND SCHEMATIC (135)

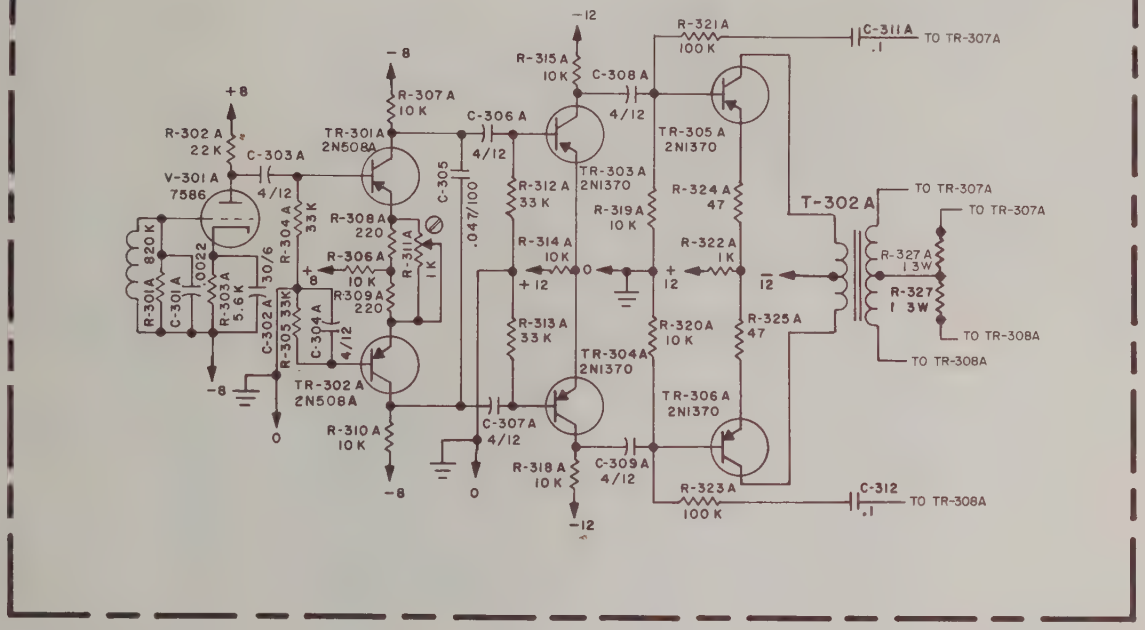
the opposite end of the armature shaft is a mechanical inertia damper. Sealed inside is a mass coupled to the outer case by a viscous silicone oil. This arrangement dampens the motor operation to produce a smooth trace.

3-18. POWER SUPPLY. The windings of transformer T-401 are connected in series or parallel by Switch S-206 to accept either 115 VAC or 230 VAC. The first stages of the servo amplifier are supplied with very stable voltages. Succeeding stages, being less critical, are fed from points of lower regulation. This arrangement separates the high load sections from the critical first stages. The power supply provides +24, ±12, and ±8 volts to the servo amplifier. The +24 volt supply is composed of bridge rectifiers, CR-409 through CR-412. This relatively unfiltered supply adequately powers the output transistors TR-307 and TR-308. The pen drop solenoid is also powered from the +24 volt supply. The voltage charges C-405 limited by R-407. When the pen switch is closed, C-405 discharges through K-401 to initiate the pen drop. Approximately 6 volts is maintained to keep the pen lowered. Zener diode CR-413, in parallel with K-401, limits the electrical surge of the capacitor discharge received by the solenoid. Bridge Rectifier CR-405 through CR-408 supplies two identical sections except for polarity reversal. After initial filtering by R-405, R-403, C-401 or R-406, R-404 and C-402, the voltage is limited by two zener diodes; CR-402 and CR-404 in the -8 volt supply; CR-401 and CR-403 in the +8 volt supply. ±12 volts is regulated by zener diodes CR-403 and CR-404.

3-19. TIME BASE. The time base on the X-axis operates on the principle that the charging current to a capacitor remains constant if the charging voltage increases at a uniform rate. Using existing facilities of the X-axis high gain chopper input servo amplifier and additional minor circuitry, these conditions are satisfied in the following manner: (Refer to figure 3-6).

a. The sweep rate is established by selection of a balance voltage for the time base. This voltage is provided by the Y-axis balance circuit and attenuated by the sweep range attenuator resistors R-232 through R-238. The voltage drop developed across the charging resistor R-241 or R-242 by the charging current of capacitor C-204 or C-205 is partially cancelled by the selected balance voltage. The difference (error voltage) is applied to the servo amplifier with the proper polarity to drive the recorder up scale. This movement also drives the X-axis balance potentiometer, R-256, in a direction to further increase the charging voltage applied to the charging capacitor C-204 or C-205, thereby increasing the capacitor charging current. The increase just balances the normal capacitor charging current decrease encountered under constant voltage conditions.

b. As there is always a small mismatch between the voltage drop across R-241 (or R-242) and the balance voltage, the time base sweep action will continue until Switch S-204 is closed. This recycles the time sweep. With the switch closed, the amplifier input is connected to the X-axis zero control potentiometers R-249A and R-249B, allowing the sweep starting



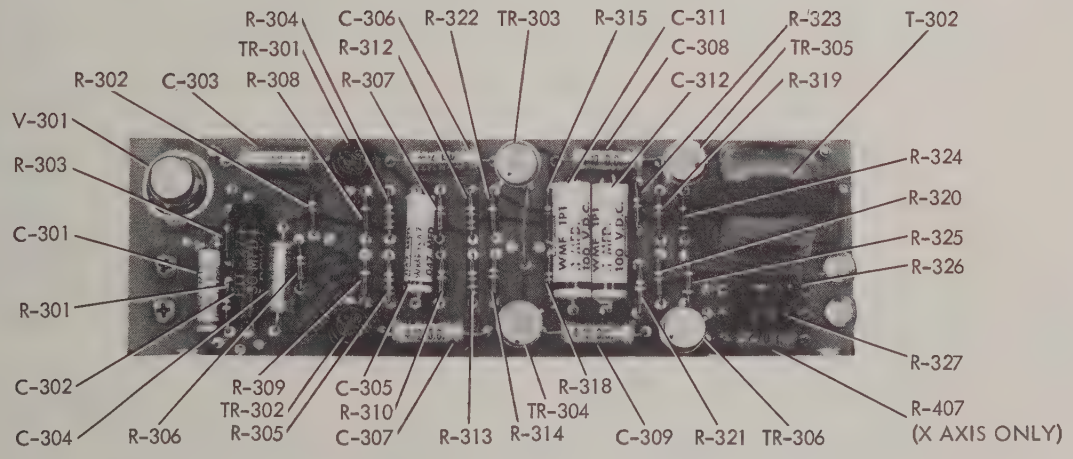




FIGURE 3-4. SERVO AMPLIFIER BOARD AND SCHEMATIC (135)

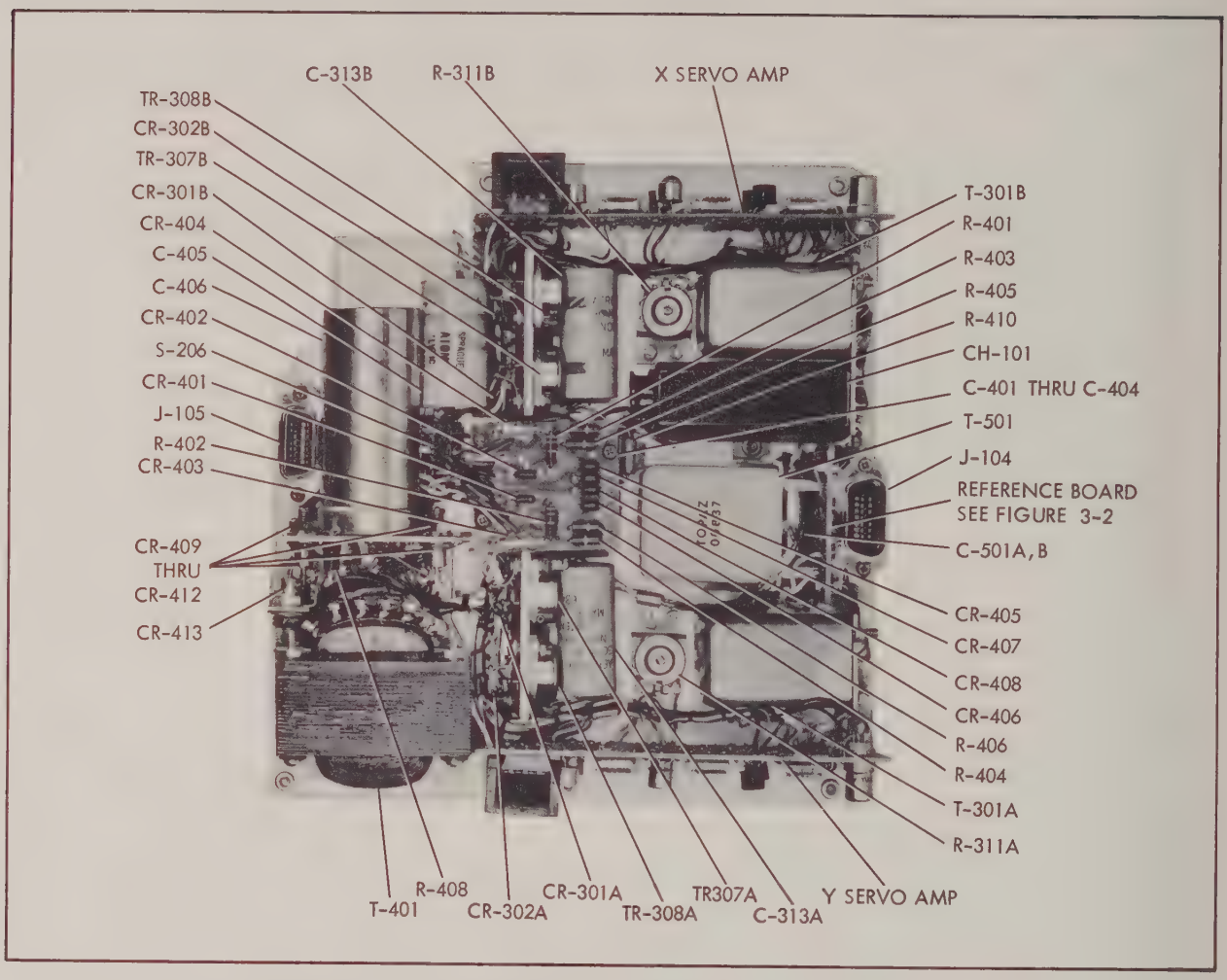



FIGURE 3-5. POWER SUPPLY AND SERVO AMPLIFIER (135)

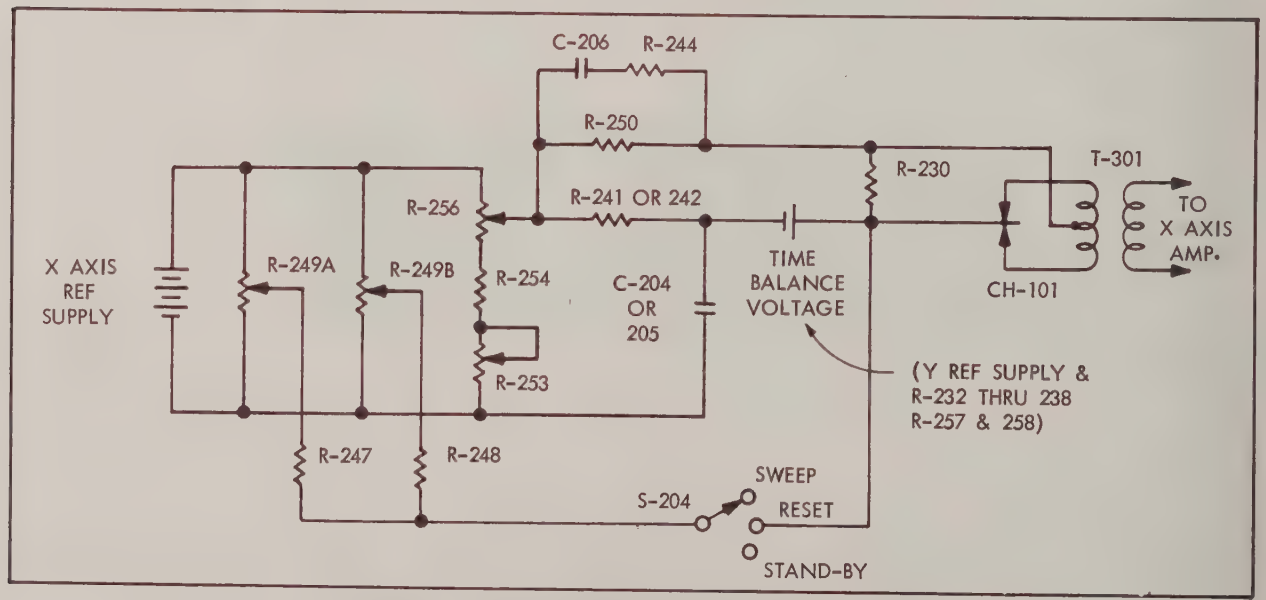



FIGURE 3-6. SIMPLIFIED TIME BASE CIRCUIT (135)

position to be placed anywhere on the X-axis. S-204 initiates the timing action by eliminating the zero positioning voltage from the circuit, allowing the unbalanced error voltage across R-241 or R-242 to be detected by the amplifier. R-244, R-250 and C-206 provide an error rate damping network for the input to the servo amplifier.

### 3-20. CIRCUIT DESCRIPTION OF THE 135A (ONE MEGOHM SERIES)

3-21. POTENTIOMETRIC INPUT. For maximum sensitivity with minimum current drain from the signal source, all Model 135A series recorders may be converted for potentiometric input. This is accomplished on the X-axis by removing a bus strap on the input circuit board (see paragraph 4-6) and on the Y-axis by setting the FUNCTION switch to "POT." Potentiometric operation is provided in the four most sensitive ranges. Full scale deflection is obtained on the 0.5 mv/div (0.2 mv/cm) ranges with inputs of 5 and 3.5 millivolts on the X and Y axes, respectively. In POT mode, the source impedance must be 50,000 ohms, or less.

3-22. INPUT ATTENUATOR. Input terminals of each axis connect to a precision voltage divider which determines the maximum allowable input voltage. The attenuator consists of four precision (±0.1%) wirewound resistors in each axis. The resistors forming the attenuator in the Y-axis are R-101 through R-104, and R-201 through R-204 in the X-axis. With the selector switch in the 0.5 mv/division (inch) or 0.2 mv/cm position, the input voltages are applied across one megohm and go directly to the balance circuit with no attenuation. In the X-axis, the voltage in the balance loop is varied by resistors R-207 through R-210. This allows a signal up to 10 millivolts/division (inch) or 5 mv/cm to be applied to the balance circuit without prior attenuation. Input

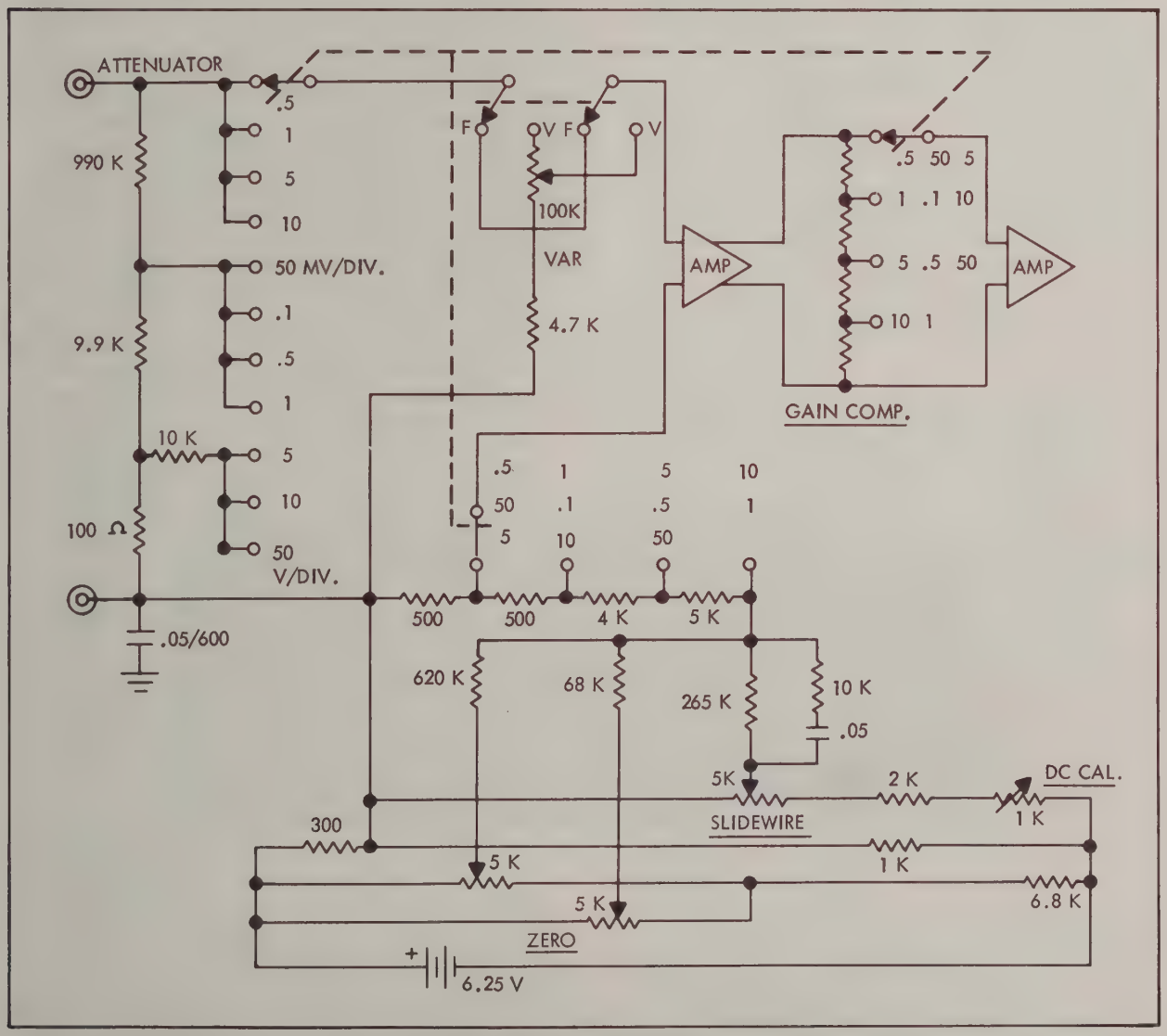



FIGURE 3-7. ONE MEGOHM INPUT CIRCUIT

signals greater than this must be attenuated before reaching the balance circuit. The attenuator switches, S-101 and S-201, simultaneously correct the balance resistor for the input range selected.

3-23. VARIABLE RANGE CIRCUITS. The FIX-VAR switches, S-102 and S-203, route input voltages through the variable range extender circuits when set in the VAR position. The variable circuit consists of potentiometer R-112 and resistor R-113 for the Y-axis, and R-206 and R-205 for the X-axis. Extension of the fixed ranges is provided by varying R-112 and R-206 for Y and X axes, respectively. When in the FIX position the signal is routed directly to the amplifier with no additional attenuation.

3-24. REFERENCE SUPPLY. The reference voltage for each axis is derived independently from a Zener controlled DC power supply, nominally 6 volts, stable to 0.03% with line variation of ±10%. The primary of transformer T-501 is supplied with 115 VAC. The rectified output from diodes CR-503 and CR-504, filtered by C-501 and R-502, is applied to Zener diode CR-502 which has high regulating ability. CR-502 is used to reduce the line voltage variation which may appear in the rectified output. Diode CR-501 is a zero temperature coefficient Zener diode which further regulates the output of the previous stage for greater stability. This diode is operated at current and voltage levels to provide temperature compensation for the reference supply. Calibrate rheostats R-117 (in Y) and R-231 (in X) are adjusted to produce full scale balance with 3.5 mv in Y and 5 mv in X.

3-25. BALANCE CIRCUIT. After passing through the input attenuator, the DC input signal is applied to the balance circuit where it is opposed by a DC cancellation voltage from the internal reference supply. The difference between these two voltages (error signal) is applied to the servo amplifiers which drive the servo motors. The rebalance potentiometers R-139 (Y-axis) and R-256 (X-axis), being mechanically coupled to the servos, are driven in a direction to cancel the error signal produced by the input voltage. Potentiometers R-124 and R-218 provide ZERO control for the Y and X axes, respectively. These potentiometers introduce into the balance circuit a controlled error signal which is cancelled in the same manner as a regular input error signal. This provides a means for placing zero anywhere within the graph limits.

3-26. CHOPPER AND INPUT TRANSFORMER. The DC difference between the input signal and the rebalance voltage (error signal) is converted to 60 cps (or 50 cps depending upon the power frequency) by the chopper. As the chopper is driven in synchronism with the power line, the AC error signal output from the transformer will be either in phase or 180 degrees out of phase with respect to the line, disregarding chopper lag and depending on the polarity of the DC error signal. The direction of rotation of the servo motor is determined by the relative phase excitation of its two windings and this phase sensing causes the motor to drive the pen carriage and coupled potentiometer in a direction to seek balance. A voltage gain of about 1.5 is realized in the transformer T-301. Total

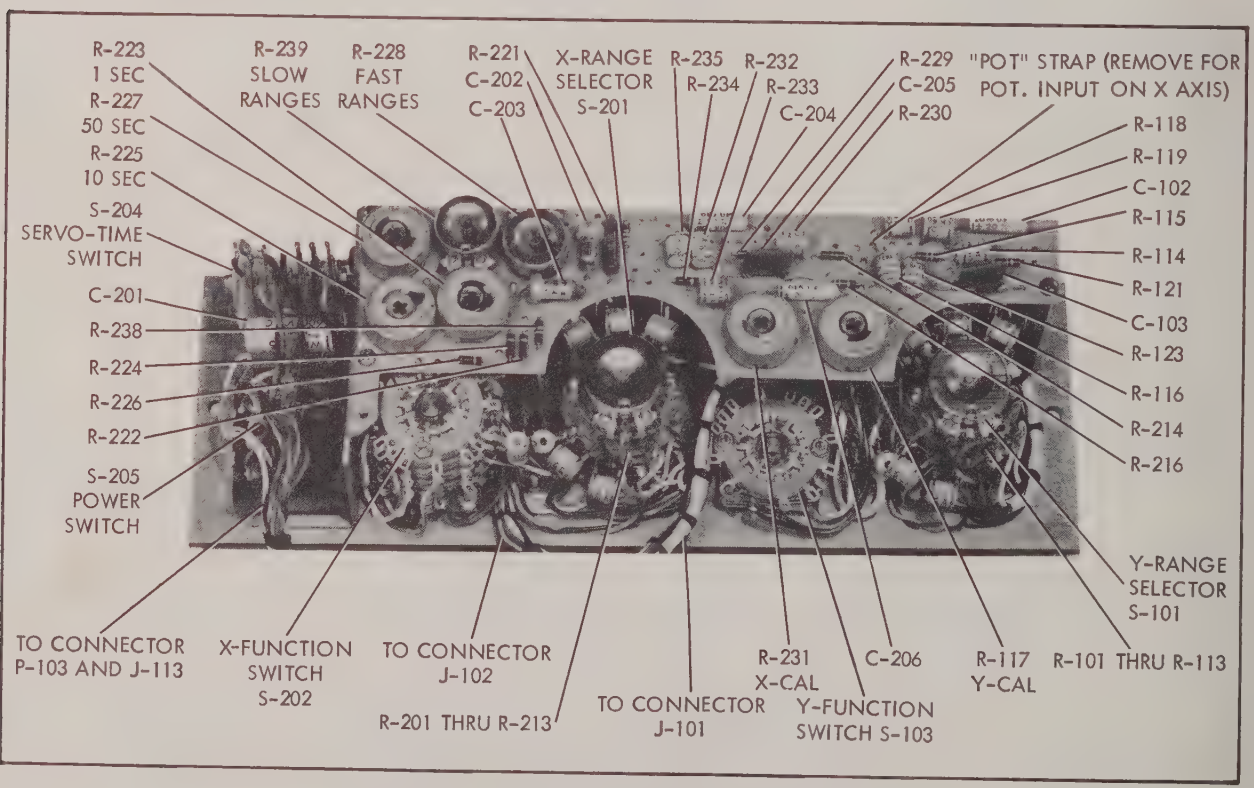



FIGURE 3-8. BALANCE CIRCUIT BOARD (135A)

magnitude of the error signal never exceeds 5 or 3.5 millivolts and, as the instrument must be sensitive to approximately 0.1% of this voltage, it is apparent that the error signals present are exceedingly small, actually in the microvolt region. With this in mind, all input circuitry is carefully engineered to minimize interference from stray hum pickup and thermal emfs.

3-27. FIRST AND SECOND, VOLTAGE AMPLIFIER STAGES. Adequate voltage amplification is provided for the power stages by Nuvistor V-301 and transistor TR-310 in a conventional cascade circuit. Nuvistor V-301 adds amplification required to compensate for the one megohm input resistance without increasing background noise.

3-28. PHASE INVERTER. The function of the phase inverter is to provide amplification and phase inversion between the incoming signal and the voltage amplifier. The second amplifier stage is capacitor coupled to the phase inverter by capacitor C-303. Phase inversion is accomplished by applying a decreasing voltage to the base of transistor TR-301. This causes a rising voltage at the collector while the emitter voltage decreases in trying to follow the base. The base of transistor TR-302 is AC grounded through capacitor C-304 and resistor R-305. The effect of the decreasing emitter signal on TR-301 is a rising signal at the collector of TR-302.

3-29. POWER AMPLIFIER STAGES. A pair of push-pull amplifiers consisting of transistors TR-303, TR-304, TR-305 and TR-306 provide further amplification. TR-305 and TR-306, operating in phase opposition, drive the output transistors TR-307 and TR-308 through transformer T-302. These latter transistors supply power to the servo motors. The major feedback loop is composed of resistors R-321, R-323, and capacitors C-311, C-312. Sufficient phase shift is introduced so that when the phase lag of the chopper is added, the output control voltage to the servo motor is approximately 90° out of phase with the reference winding of that motor.

3-30. POWER SUPPLY. The windings of transformer T-401 are connected in series or parallel by Switch S-206 to accept either 115 VAC or 230 VAC. The first stages of the servo amplifier are supplied with very stable voltages. Succeeding stages, being less critical, are fed from points of lower regulation. This arrangement separates the high load sections from the criticalfirst stages. The power supply provides +24, ±12, ±8 volts to the servo amplifier. The +24 volt supply is composed of bridge rectifiers CR-409 through CR-412. This relatively unfiltered supply adequately powers the output transistors TR-307 and TR-308. The pen drop solenoid is also powered from the +24 volt supply. The voltage charges C-405 limited by R-407. When the switch is closed, C-405 discharges through K-401 to initiate the pen drop. Approximately 6 volts is maintained to keep the pen lowered. CR-413, in parallel with K-401, limits the electrical surge of the capacitor discharge received by the solenoid. Bridge Rectifier CR-405 through CR-408 supplies two identical sections except for polarity reversal. After initial filtering by R-405, R-403, C-401, R-406, R-404 and C-402, the voltage is limited by three Zener diodes; CR-402, CR-404, and CR-414 in the -8 volt supply; CR-401, CR-403, and CR-415 in the +8 volt supply. Separate diodes are used in each axis for the -8 and +8 supply points in order to prevent interaction between the two axes. ±12 volts power is regulated by the Zener diodes CR-403 and CR-404.

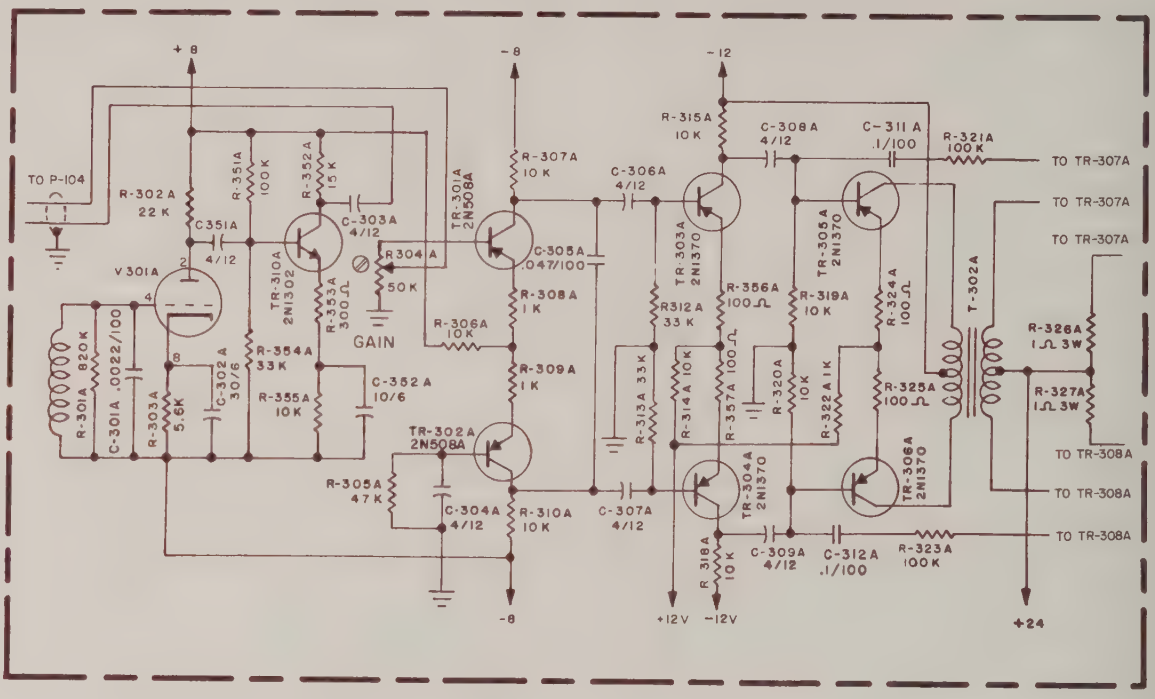
3-31. TIME BASE. The time base on the X-axis operates on the principle that the charging current to a capacitor remains constant if the charging voltage increases at a uniform rate. Using existing facilities of the X-axis high gain chopper input servo amplifier and additional minor circuitry, these conditions are satisfied in the following manner: (Refer to Figure 3-11).

a. The sweep rate is established by selection of a balance voltage for the time base. This voltage is provided by the Y-axis balance circuit and attenuated by the sweep range attenuator, resistors R-222 through R-227. The voltage drop developed across the charging resistor (R-236 or R-237) by the charging current of capacitor C-202 or C-203 is partially cancelled by the selected balance voltage. The difference, or error voltage, is applied to the servo amplifier with the proper polarity to drive the recorder up scale. This movement also drives the X-axis balance potentiometer, R-256, in a direction to further increase the charging voltage applied to the charging capacitor C-202 or C-203, thereby increasing the capacitor charging current. The increase just balances the normal capacitor charging current decrease encountered under constant voltage conditions.

b. As there is always a small mismatch between the voltage drop across R-236 (or R-237) and the balance voltage, the time sweep action will continue until switch S-204 is closed. This recycles the time sweep. With the switch closed, the amplifier input is connected to the X-axis zero control circuit which allows positioning of the sweep start anywhere on the X-axis. Opening of switch S-204 initiates the timing action by eliminating the zero positioning voltage from the circuit, allowing the unbalanced error voltage across R-236 or R-237 to be detected by the amplifier. R-229, R-230 and C-205 provide an error rate damping network for the input to the servo amplifier.

3-32. DAMPING. Capacitor C-103 (Y-axis) and C-205 (X-axis) draw a charging current whenever a change in input occurs, thus increasing the rate of appearance of the balance voltage across resistor string, R-105, R-106, R-107, and R-108 (Y-axis) and R-207, R-208, R-209 and R-210 (X-axis). This phase advance in the slowly varying error signal causes an "anticipatory" approach to the balance point, producing damping.

3-33. MOTOR AND MECHANICAL DAMPER. The servo motor is a Moseley 3 watt, 2 phase induction motor, one phase of which is energized from the AC line, and the other excited in phase quadrature from the amplifier output. Direction of motor rotation is determined by whether a leading or lagging 90°



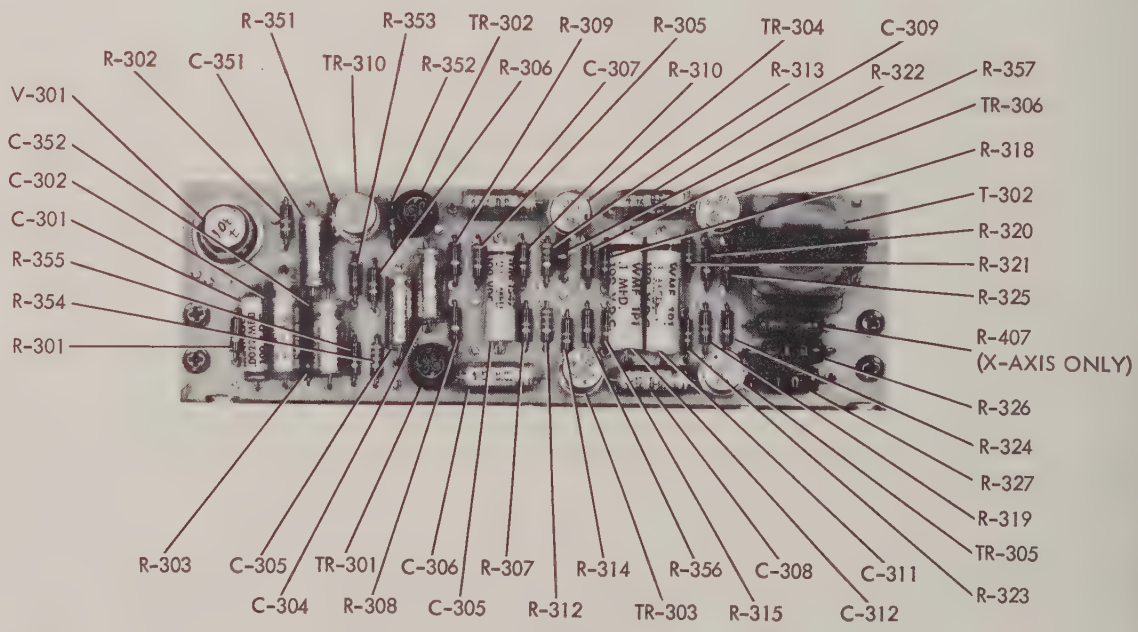




FIGURE 3-9. SERVO AMPLIFIER BOARD AND SCHEMATIC (135A)

relationship exists. A pinion on the motor shaft meshes with a large aluminum gear which drives a sheave through a friction clutch. The reduction is 10:1. On the opposite end of the armature shaft is a mechanical inertial damper. Sealed inside is a mass coupled to the outer case by a viscous silicone oil. This arrangement dampens the motor operation to produce a smooth trace when recording.

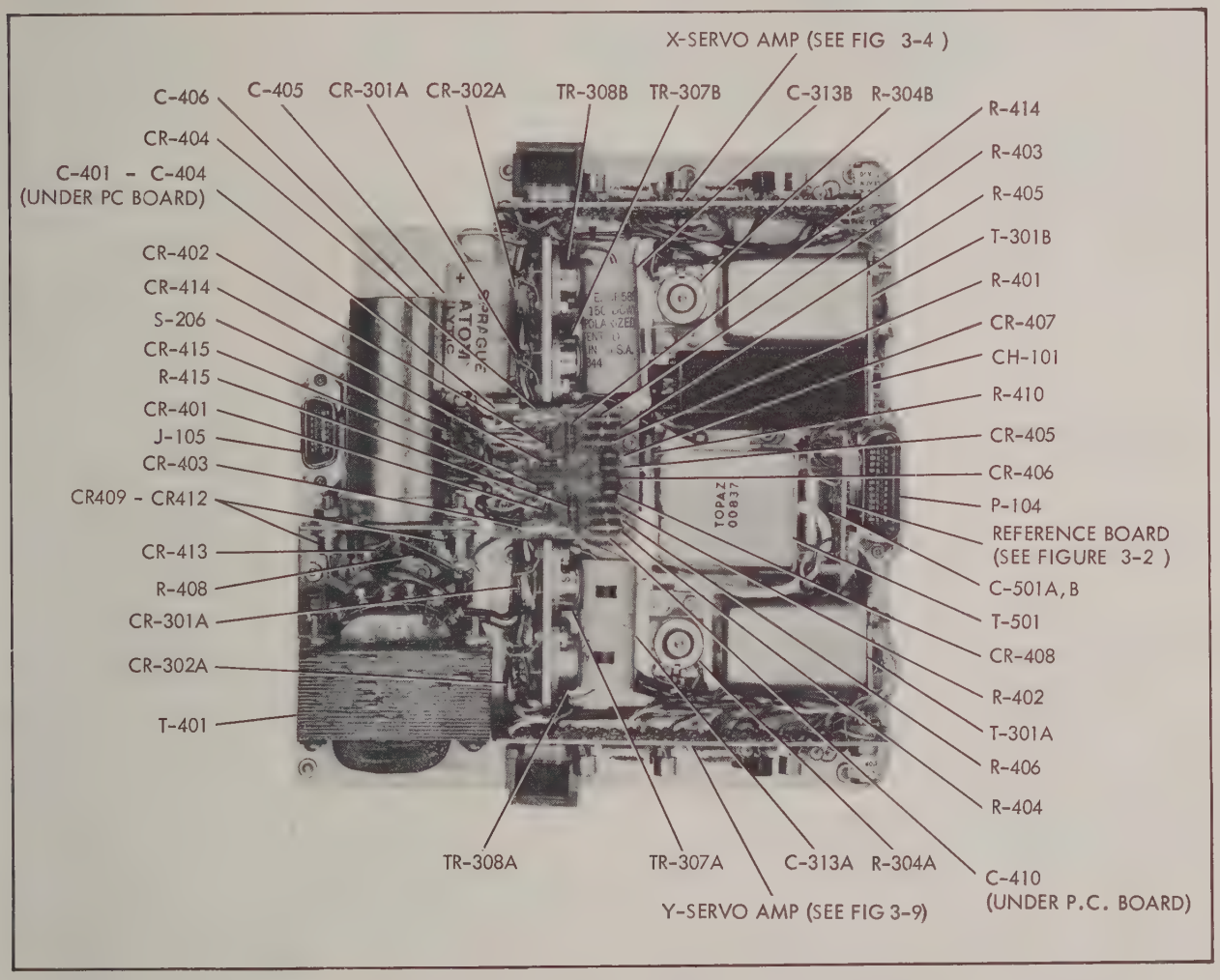



FIGURE 3-10. POWER SUPPLY AND SERVO AMPLIFIER (135A)

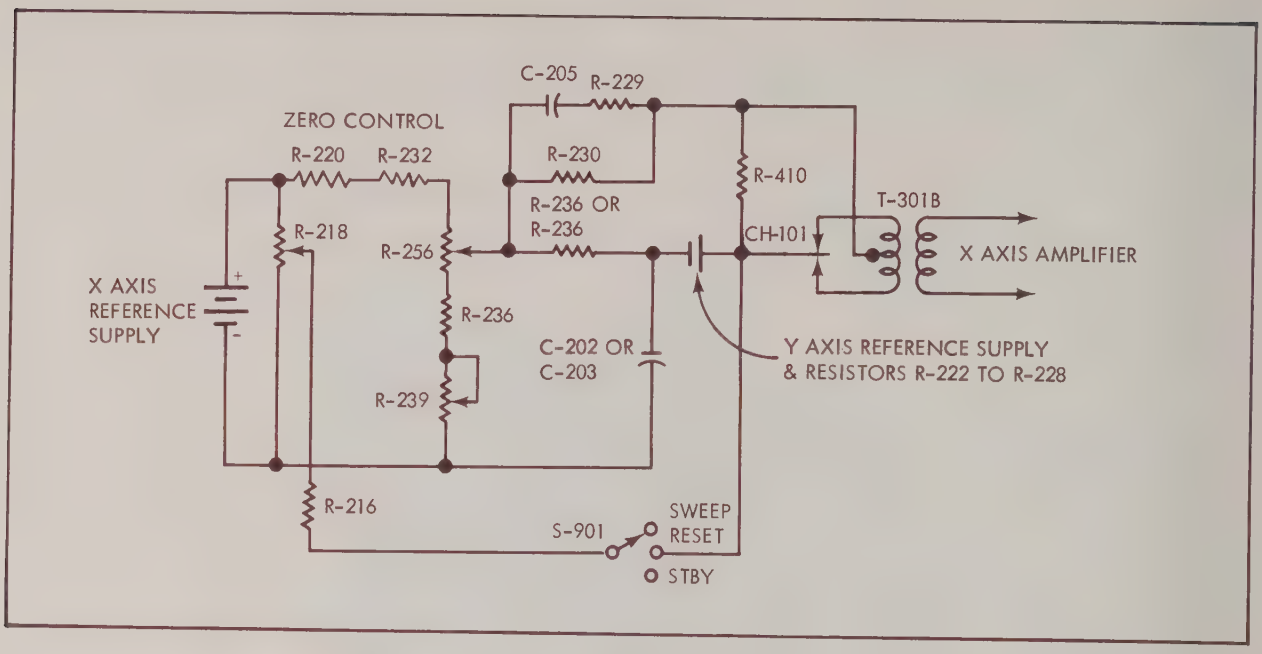



FIGURE 3-11. SIMPLIFIED TIME BASE CIRCUIT (135A)

# SECTION IV
# MAINTENANCE

## 4-1. GENERAL MAINTENANCE

4-2. AUTOGRAF recorders should be protected from dust by covering when not in use. Procedures for lubrication and cleaning of pen assembly are included in this section.

4-3. LUBRICATION: No lubrication is required or recommended to any moving mechanical parts. Thorough cleaning however should be performed periodically. The time between periodic maintenance is determined by type of operation, air contamination, and climatic conditions.

## 4-4. ELECTRICAL MAINTENANCE

4-5. TROUBLE SHOOTING. Malfunctions, other than those caused by improper adjustments, may be localized by reference to the following chart. Reference made to Test Points (TP) are oscilloscope waveforms which may be found on the schematics in Section V.

4-6. POTENTIOMETRIC INPUT. Maximum sensitivity with minimum current drain from the signal source may be obtained by converting to potentiometric input. A POT position is provided on the Y FUNCTION switch. The X-axis is placed in this mode by removing a bus strap from the input circuit board. (See Figures 3-3 and 3-8). On all models except one megohm recorders, range switches must be set at 0.5 mv/div (or 0.2 mv/cm) and the source impedance must be 1500 ohms, or less. One megohm models may be operated in POT mode on the four most sensitive ranges with a source impedance 50K or less.

4-7. CALIBRATION REFERENCE SUPPLY. Zener reference supply voltage is standardized during manufacture against a Weston Standard Cell. Drift or variation of this voltage is negligible as it is temperature stabilized as well as regulated. If, however, recalibration is indicated, the following procedure should be followed. (Access to all calibration controls and the input circuit board is obtained by removing the bottom plate).

a. Energize the recorder and allow approximately 10 minutes for the various components to reach a stabilizing temperature.

b. Set the FUNCTION switches to VOLTS (MV on metric models).

c. Set the RANGE switches to 0.1 volts/division; 50 mv/cm on metric models).

d. Adjust zero controls to bring pen to exactly 10 inches on the X-axis scale and 7 inches on the Y-axis scale; (20 cm on X-axis and 8 cm on Y-axis on metric models).

e. Set the FIX-VAR switches to FIX.

f. With reversed polarity connect an accurately established one volt DC supply (as obtained, for example, from an L & N precision potentiometer and Weston Standard Cell), to the X-axis and 0.7 volts DC to the Y-axis.

g. Adjust calibration controls to bring pen into exact agreement with the "O" mark on the X and Y scales. Removal of the input signals should cause the pen and carriage to return to their original positions. Repeat calibration procedures until accurate repositioning is achieved.

h. In the event "O" cannot be reached by use of the calibration controls, the electronic reference supply should be checked for an output of approximately 6.25 volts (±5%).

4-8. TIME BASE CALIBRATION. The various sweep circuit intervals are established during manufacture by selection of special components for each

| INDICATION | PROBABLE CAUSE | LOCATING CAUSE |
|---|---|---|
| 1. Sluggish response of zero controls on 4 most sensitive ranges of one megohm models. | 1. This condition is normal with no input applied. Short circuit input for normal response (MAX. SOURCE RESISTANCE 50K) | 1. N/A |
| 2. Noisy, or rough trace. | 1. Instrument not grounded.<br>2. Worn or dirty potentiometer.<br>3. Insufficient contact pressure or improper positioning of wiper on slidewire balance potentiometers.<br>4. Noisy Nuvistor or transistors in amplifier. (Microphone input trans. possible cause).<br>5. Backlash adjustment incorrect.<br>6. Regulator zener diode for V-301 Filaments defective. | 1. 115/230 VAC POWER GND. REQ.<br>2. See paragraphs 4-11 and 4-21 for tests and corrective procedures.<br>3. Contact at 45° angle before installation with contact pressure of 15 grams (approximate values).<br>4. Check TP-2, if noise is present check TP-1. This will localize the trouble to a few components.<br>5. See Paragraph 4-24 for desirable setting.<br>6. Check TP-7. |
| 3. Dead zone, manifested by inability to obtain an acceptable retrace and/or poor damping. | 1. Friction in mechanical linkage.<br>2. Loss of voltage gain due to defective component.<br>3. Unbalanced output transistors, TR-307 and TR-308. | 1. Inspect all moving parts, Pantograph arm, gears, bearings, etc.<br>2. Check TP-2, TP-4, TP-5 and TP-1.<br>3. Check TP-2 and TP-2C, both points should produce identical waveforms. |
| 4. Sweep velocity decreases and appears non-linear. Note: Sweep runs backwards See cause #3 | 1. Low servo gain or loss of gain resulting in loss of hull.<br>2. Friction in mechanical linkage.<br>3. Leakage in the 5 and 30 mfd tantalum capacitors. | 1. Check TP-3 and TP-2.<br>2. Inspect all moving parts, pantograph arm, gears, bearings, etc.<br>3. Replace |
| 5. Interaction between axes. | 1. Unbalanced output transistors, TR-307 and TR-308.<br>2. Microphonic Nuvistor or input transformer in amplifier stage.<br>3. Failure of low voltage supply regulators.<br>4. Chopper malfunctioning. | 1. Check TP-2 and TP-2C, both points should produce identical waveforms.<br>2. Check TP-1.<br>3. Check TP-4 and TP-5.<br>4. Check TP-1.<br>5. Check TP-7. |

FIGURE 4-1. TROUBLE SHOOTING CHART (Sheet 1 of 2)

| INDICATION | PROBABLE CAUSE | LOCATING CAUSE |
|---|---|---|
| | 5. REGULATOR ZENER DIODE FOR V301 FILAMENTS defective. | |
| 6. Loss of Vacuum Holddown. | 1. Obstruction in intake line.<br>2. Clogged filter.<br>3. Pump failure.<br>4. Leak at O-ring seal (platen and vacuum line).<br>5. Broken V-belt.<br>6. Motor inoperative. | 1. See Paragraph 4-25 for complete vacuum system maintenance.<br>2. See Paragraph 4-27.<br>3. Same as No. 1.<br>4. a. Tighten platen screws.<br>b. Replace O-ring.<br>5. Visual inspection.<br>6. Visual inspection. |

FIGURE 4-1. TROUBLE SHOOTING CHART (Sheet 2 of 2)

instrument. If excessive deviation from the fixed intervals is experienced, proceed as follows:

a. For sweep periods of 50 seconds or over, a rough check of timing accuracy may be made with a stop watch.

b. For shorter sweep periods an accurate timing function should be generated and applied to the Y-axis for comparison with the actual X-axis advance.

c. Deviations from full scale accuracy are corrected by making adjustments to one or more of the calibrate potentiometers. Tools required are a screwdriver and an accurate timing device. Use of a time function generator is required if complete calibration is found necessary. The chart of Figure 4-2 applies to all Model 135 recorders. See Figures 3-3 and 3-8 for potentiometer locations.

4-9. DAMPING CHARACTERISTICS. No damping adjustments are provided. A fixed damping circuit designed to provide slightly underdamped operation is described in Section III. Proper gain settings are necessary to produce optimum performance.

4-10. GAIN ADJUSTMENTS. The gain potentiometers are located on the servo amplifier and power supply section. They are appropriately labeled and adjustable from the back of the recorder with a common screwdriver.

a. Set the gain controls to minimum(fully CCW).

b. Introduce a test signal into each axis. (Figure 4-3 illustrates a simple generator which may be constructed for this purpose). If the control knob on the generator is rotated CW to draw a line and then CCW to draw back across the same line, the result is called a "retrace" curve. The space between the up-line and the down-line is the retrace error. The amount of retrace error is governed by the gain setting, damping, servo system friction, and backlash.

| Potentiometer Symbol | Location | Adjusts | Corresp. Metric Symbol | Corresp. One Meg. Symbol |
|---|---|---|---|---|
| R-245 | Printed Circuit Board | Time-Calibrate Provides simultaneous adjustment of the first three (two on one meg.) sweep ranges. 0.5 sec/inch (0.2 sec/cm for metric) | Same | R-228 |

FIGURE 4-2. TIME SWEEP CALIBRATION CHART (Sheet 1 of 2)

| Potentiometer Symbol | Location | Adjusts | Corresp. Metric Symbol | Corresp. One Meg. Symbol |
|---|---|---|---|---|
| *R-233 | Printed Circuit Board | 1.0 sec/inch (0.5 sec/cm for Metric) | Same | *R-223 |
| *R-234 | Printed Circuit Board | 2.0 sec/inch (1.0 sec/cm for Metric) | Same | Not applicable |
| R-246 | Printed Circuit Board | Time-Calibrate Provides simultaneous adjustments of the last four (three on one meg.) sweep ranges. 5.0 sec/inch (2.0 sec/cm for Metric) | Same | R-239 |
| *R-235 | Printed Circuit Board | 10 sec/inch (5 sec/cm for Metric) | Same | *R-225 |
| *R-236 | Printed Circuit Board | 20 sec/inch (10 sec/cm for Metric) | Same | Not applicable |
| *R-237 | Printed Circuit Board | 50 sec/inch (20 sec/cm for Metric) | Same | *R-226 |

*NOTE: These trim potentiometers are set and sealed at the factory and should not be disturbed unless absolutely necessary and then only by following the procedure listed above using an accurate time function generator.

FIGURE 4-2. TIME SWEEP CALIBRATION CHART (Sheet 2 of 2)

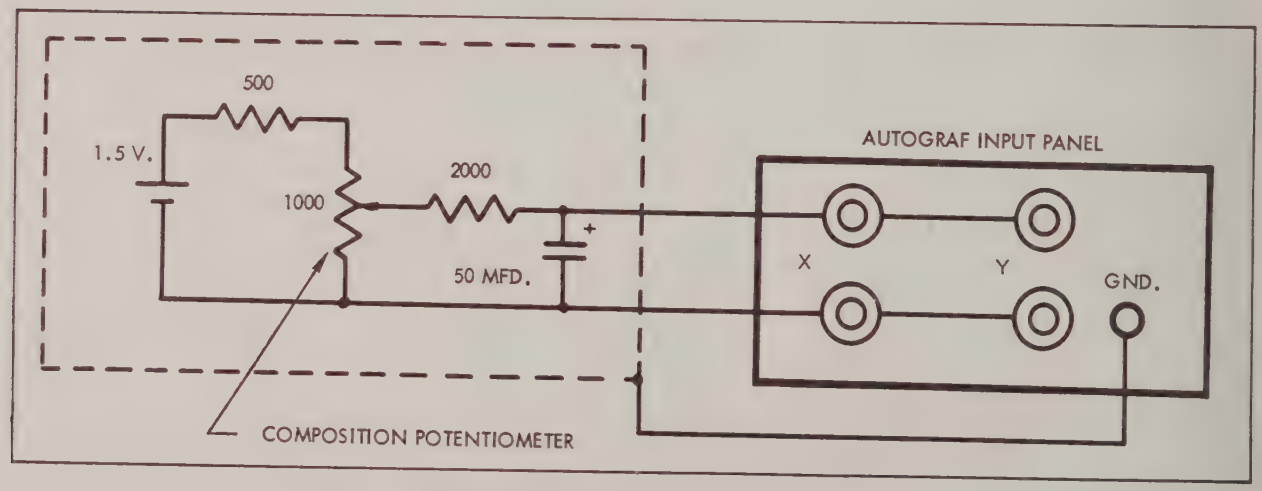



FIGURE 4-3. TEST GENERATOR

c. With the recorder range controls set at 0.1 volts/division (inch) for X and 0.5 volts/division (inch) for Y, the generator will draw a nearly horizontal line. Any retrace error in this case will be due largely to low gain in the Y-axis. Adjust the Y-gain control for as close to zero retrace as possible.

d. Similarly, if the range controls are set at 0.5 volts/division (inch) on X and 0.1 volts/division (inch) on Y, a nearly vertical line will be drawn and any retrace error will be due to low gain in the X-axis. Adjust the X-gain control for optimum retrace error.

4-11. LINEARITY CHECKS. Operating linearity may be determined as follows:

a. A useful check of recorder linearity may be made by connecting the output of the test generator to both axes of the recorder simultaneously. If suitable signals are chosen to produce a line extending entirely across the paper, essentially from corner to corner, the straightness of this line will be a good indication of recorder linearity. If both pen and carriage servo systems are tight, a smooth straight line will be drawn. If the line is curved to any appreciable extent, the trouble may be due to a defective or worn potentiometer, R-139 and/or R-256.

b. Linearity of time sweep action may be checked by generating an accurate linear function, applying it to the Y-axis, and actuating the time sweep. Any distinguishable curvature of the drawn line when compared to a straight edge indicates non-linearity. The degree of non-linearity will be a function of several factors, including the generated signal and the basic accuracy of the recorder. Refer to trouble shooting chart (Figure 4-1) for possible corrective measures.

c. Assuming that both X and Y axes have been examined independently and adjusted by means of the retrace curves described above, the attenuator switches may be set to identical values in both X and Y to produce a straight line of 45 degrees angle. If the retrace tests made on X and Y demonstrate essentially zero retrace, or approximately the same in both axes, the gap which appears in the 45 degree trace line (if any) will be due to a phase difference or time lag between the two recording axes. Phase adjustment is accomplished by altering the value of one of the series resistors in the input filter. The most convenient ones to change for this correction are R-128 and R-228. If these resistors are found to be other than 470 ohms, phase correction was made during manufacture.

NOTE: On one megohm input recorders, phase correction is made by changing the value of damping capacitors C-103 and C-205.

4-12. SERVO STANDBY VOLTAGE. A recorder which is performing properly will have a low "standby" voltage supplying each of its servo motors. This may be verified by placing an AC voltmeter from collector to collector across the output transistors TR-307 and TR-308. This is equivalent to placing the voltmeter across the control phase winding of the servo motor.

| Incorrect | | Correct |
|---|---|---|
| | Set X on 0.1 v/in. range. Set Y on 0.5 v/in. range. Rock potentiometer control of tester back and forth. Poor retrace indicates insufficient gain in Y channel. (To check X channel, set X to 0.5 v/in.; Y to 0.1 v/in.) | |
| | Use same settings as above.<br><br>Rough writing indicates too much gain in axis being tested. | |
| | Use same settings as above.<br><br>Roughness appearing in one part of trace is probably due to a worn or dirty balance potentiometer. | |
| | Use same settings as above.<br><br>Three cyclic variations in trace indicate gear train mesh is too tightly adjusted. | |
| | Connect a 1-1/2 volt battery to the Y input. Leave X input open. Slowly rotate zero control while rapidly flipping the Y attenuator knob between 0.5 and 1.0 v/in. positions. Excessive overshoot and oscillation indicates too much gain in Y axis. Repeat for X axis. | |

FIGURE 4-4. PERFORMANCE CHART

A standby voltage of from 3 to 5 volts is normal. If the servo is coerced from its resting position by manually moving the pen carriage, the standby voltage will rise rapidly to a maximum of about 30 volts when the drive clutch should slip, accompanied by a whirring noise at about 15 volts.

4-13. ONE MEGOHM INPUT IMPEDANCE MEASUREMENT. If measurement of the input impedance is required on the one megohm recorder, a special test procedure and circuit is required. Simply measuring input resistance with an ohm-meter will give erroneous results.

a. Construct a test circuit as illustrated in Figure 4-5.

b. Set the recorder attenuator control in the axis to be measured to the 0.5 millivolt/division range and adjust recorder zero control to position the pen at zero.

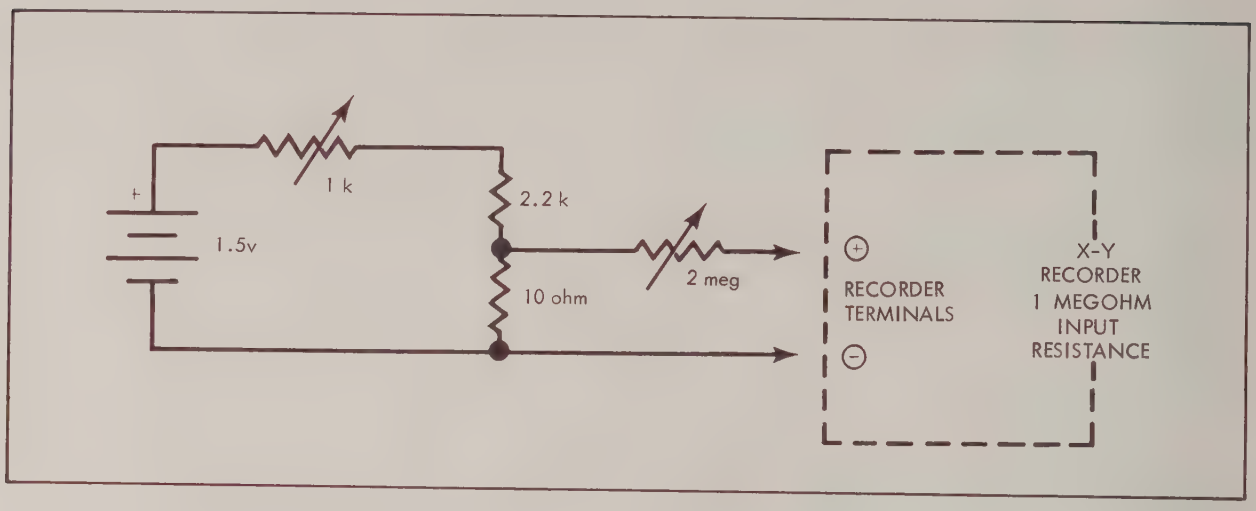



FIGURE 4-5. TEST CIRCUIT

c. Connect the low impedance, low voltage source to the input terminals as shown. Observe polarity.

d. With the variable two megohm potentiometer at zero resistance, adjust the 1 K potentiometer for full scale pen deflection.

e. Increase the resistance of the two megohm potentiometer until the pen returns to the half scale position. At this point, the portion of the two megohm pot remaining in the circuit should measure one megohm, matching the input resistance of the recorder.

f. Higher ranges may be checked in a similar manner, using a higher voltage source.

## 4-14. MECHANICAL MAINTENANCE

4-15. DISASSEMBLY. Access to the various components of the recorder is attained as follows:

a. The Model 135 recorder is unitized into five major divisions: carrying handle or wing brackets (as ordered), recording platen and trim pieces, frame and mechanical assembly, servo amplifiers and power supply, and control box. These are shown in physical relationship in Figure 5-1. The AC power cord may also be removed for convenience during transportation.

b. Remove power cord.

c. For access to the servo amplifiers and/or power supply, place the recorder in an inverted position and remove ten #6-32 machine screws which fasten the unit to the frame. Pull the unit directly upward from the frame. When replacing, be sure to align the connector plugs with the corresponding receptacles before replacing screws.

d. Removing the servo amplifier and power supply will afford access to the mechanical drive mechanism. The drive system may be reached more easily by removing the recording platen. Place the carriage at the far right of travel, remove seven mounting screws, and slide table off to the left. The vacuum connection is automatically separated when the table is removed. When replacing the platen, tighten the mounting screws securely to reseat this connection.

e. Wing brackets, if supplied, are attached to the sides of the recorder with two machine screws. The carrying handle is removed by loosening the large screws used for pivots.

f. The trim pieces at the top and bottom of the recording area snap into place with spring clips. The recording platen is removed by first removing the aluminum strip covering the X-axis rebalance potentiometer and then the four machine screws holding the platen.

g. The control box is separated from the recording mechanism by removing the two slotted screws in the right side. Electrical connections from the control box to the amplifier are through plug-in connectors. Removal of machine screws from the top, bottom and sides will expose all electrical components for servicing.

4-16. PEN MAINTENANCE. Pen writing failures may be caused by dried ink, sediment, air bubbles in feed line, and general neglect. Dirt and ink sediment cause the most difficulty. Dried ink forms a brittle crust particles of which, together with dirt, build up in the supply line until the ink stops flowing. Pen assemblies should be cleaned thoroughly every two to four weeks or each time new ink is added. Clean by soaking in alcohol or hot water. Clogging during operation may be cleared by one or more of the following steps:

a. Apply air pressure to ink filler hole with syringe.

b. Internally clean tip by inserting the stiff wire supplied in the accessory kit.

c. Soak pen assembly in alcohol or hot water.

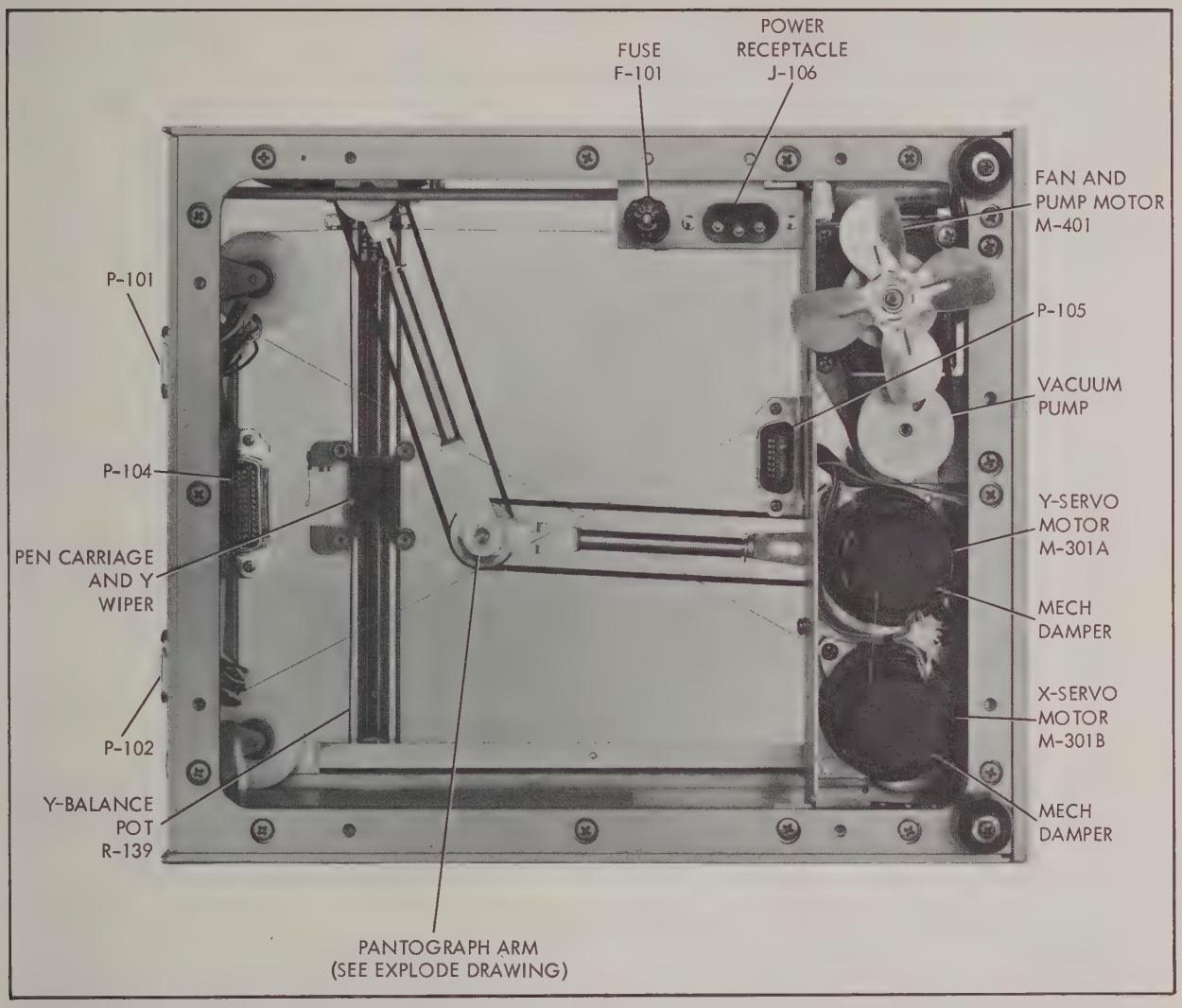



FIGURE 4-6. FRAME AND MECHANICAL ASSEMBLY (BOTTOM VIEW)

d. Prior to storage, flush the pen and apply vaseline to the tip.

4-17. PEN TIP POLISHING. In general, pen tips should be polished sparingly. Occasionally a pen may have a slight burr at the aperture and may not ride flat on the paper. This may be corrected by polishing. Recommended polishing material is #000 crocus cloth. Tape a piece of cloth on the writing surface under the pen tip and moisten with ink by priming the pen. Now introduce a 60 cycle oscillation to the pen and polish for a few seconds. Over polishing will flatten the pen tip and produce "skipping" at fast recording speeds.

4-18. ADJUSTMENT OF PEN MOUNT. The pen mount is held on the carriage beam by eccentrically mounted rollers. To adjust, loosen screws on the pen tip side of the mount and adjust eccentrics with a stiff wire. Retighten screws.

4-19. ADJUSTMENT OF PEN CARRIAGE BEAM. If a vertical pen trace deviates from perpendicular when compared with correctly aligned paper grids, the carriage beam should be adjusted. Remove the servo amplifier and power supply and loosen the two machine screws at the lower end of the beam. Manually move the beam in the indicated direction until parallel with the paper grids. Retighten both screws.

4-20. REMOVAL OF PEN CARRIAGE BEAM. It is necessary to dismount the pen carriage beam for cleaning or replacing the Y-axis balance potentiometer and for installing a new nylon drive cord. (Use a #2 Phillips screwdriver).

a. Remove the pen from the pen mounting block.

b. Remove the top and bottom aluminum trim strips.

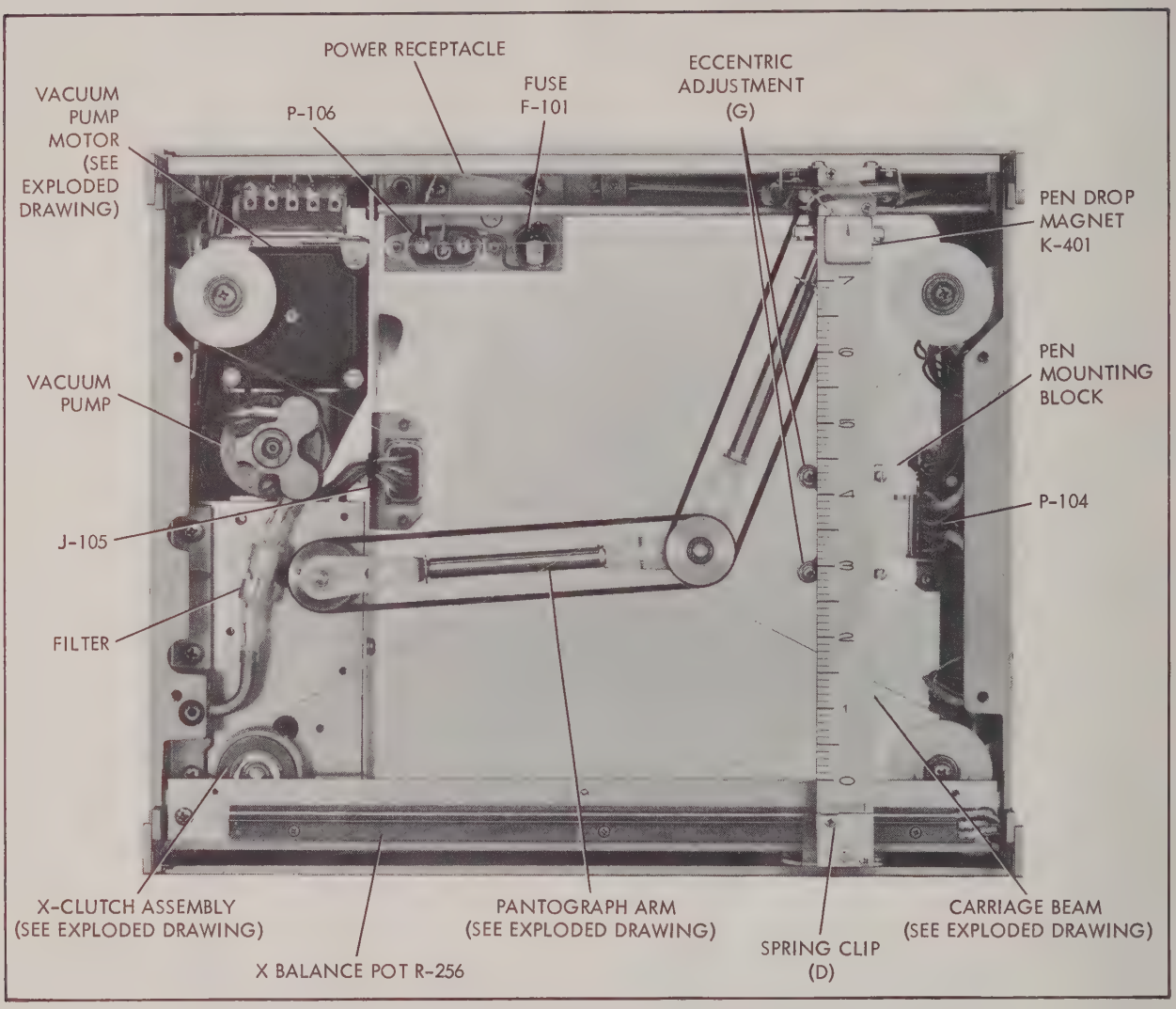



FIGURE 4-7. FRAME AND MECHANICAL ASSEMBLY (TOP VIEW)

c. Secure X-axis cable with masking tape and remove one machine screw from the center of the lower end of the beam and two machine screws on either side of the top of the beam. Refer to exploded view in Section V.

d. The upper end of the beam is now held only by the nylon cord tension around the upper drive pulley. Slip the cord from the pulley. With wires still connected to the Y-balance potentiometer, the carriage beam has only a limited area of movement.

e. Slide the beam upwards, separating it from the lower carriage track. Carefully turn the beam over to expose the potentiometer and drive mechanism.

f. Reassemble by reversing the preceding steps.

4-21. LINEAR POTENTIOMETER MAINTENANCE. Irregular of "jumpy" plots produced by smooth signals on a properly adjusted recorder may indicate a worn or dirty rebalance potentiometer. The resistance wire mandrel may be cleaned with a moderately stiff brush using gentle strokes at right angles to its length (i.e. parallel to the individual turns of fine wire). Great care should be taken to prevent damage during this operation. The solid return wire may be cleaned with a lint free cloth moistened slightly with a solvent such as Moseley contact cleaner Type 391-0001 which will not leave a greasy residue. The sliding contact should be adjusted to about a 45 degree angle before installation. Correct contact pressure is approximately 15 grams.

4-22. POTENTIOMETER REPLACEMENT. Under paragraph 4-11 a test is described for checking performance of the rebalance potentiometers. If replacement of these potentiometers is indicated, complete assemblies should be obtained from the factory. The following is installation procedure:

a. Y-AXIS REBALANCE POTENTIOMETER. This unit is located under the carriage beam.

(1) Remove the carriage beam as described in paragraph 4-20.

(2) Dismount the Y scale by removing machine screws from top and bottom of the carriage beam. This exposes three screws mounting the potentiometer.

(3) Unsolder the three wires connected to the potentiometer noting that the yellow lead connects to the heavy solid wire, the green lead to the center terminal leading to the lower end of the mandrel, and the blue lead to the top of the mandrel.

(4) Remove the pen mount by loosening the eccentric mounted bearings.

(5) Take out the three machine screws holding the potentiometer and remove from carriage beam.

(6) Install the new potentiometer unit and re-assemble.

b. X-AXIS REBALANCE POTENTIOMETER. This unit is located behind the rear panel of the recorder.

(1) Remove the front trim strip and the protection strip over the rebalance potentiometer.

(2) Unsolder the three wires on the right side of the potentiometer noting that the blue lead connects to the left end, the red lead to the center terminal and large solid wire, and the yellow to the small solid wire which connects to the right end.

(3) Remove the three machine screws holding the potentiometer to the frame.

(4) When installing a new potentiometer care should be taken to prevent damage to the wipers. Both wipers should be lifted slightly to slide new unit in place. Place one wiper on the solid wire and one on the wire mandrel.

(5) Reassemble.

4-23. WIPER REPLACEMENT. This unit is located on the pen carriage. It is of a softer metal and should wear out long before the potentiometer. New wiper assemblies are available from the factory. To install, proceed as follows:

a. Y-AXIS WIPER. This unit is located on the pen carriage.

(1) Remove the pen from the pen mounting block.

(2) Loosen the two screws mounting the eccentric rollers on the underside of the pen block.

(3) Position the two rollers with the aid of a stiff wire, placing the eccentric holes close to the carriage beam.

(4) Separate the pen carriage from the carriage beam and remove the nylon cord from around the lower pulley of the beam. This will allow limited movement of the pen carriage. Remove the beam from the recorder (see paragraph 4-20) and the nylon cord from the upper pulley.

CAUTION: Do not remove the nylon cord from the pen carriage as this would require restringing the Y-axis. If this does occur, refer to Section 4-32 for restringing instructions.

(5) Remove the old wiper and mounting rivet being careful not to enlarge the mounting hole.

(6) Rivet the new wiper to the pen carriage and reassemble.

b. X-AXIS WIPER. This unit is located on the Y-slider block at the lower end of the pen carriage beam. New wiper assemblies are available from the factory.

(1) Remove the front trim strip and potentiometer guard cover.

(2) Referring to exploded view in Section 5, remove the screw mounting the wiper assembly A-8870 to the lower slider block.

(3) Install a new wiper assembly.

(4) Position the assembly so that one wiper contacts the resistance wire mandrel and the other the solid return wire.

(5) Re-install the trim strip and guard cover.

4-24. ADJUSTMENT OF GEAR MESH. Backlash of the gear drive system may be adjusted as follows:

a. Remove the recording platen.

b. Loosen the motor mount clamp screws.

c. Rotate the motor assembly slightly, first in one direction and then in the other, while moving the pen carriage back and forth until the motor pinion rotates freely with minimum backlash. This procedure varies the mesh between motor pinion and clutch gear due to an eccentric mounting shoulder. A slight amount of backlash is desirable for optimum operation.

d. Tighten motor mounting screws and recheck for optimum backlash.

## 4-25. VACUUM SYSTEM MAINTENANCE

4-26. VACUUM PUMP. The vacuum pump tends to collect dust, dirt and even ink through the system. This could result in reduced efficiency or "freezing". Periodic flushing is recommended every 100 hours of operation. An effective method of flushing is as follows:

a. Disconnect intake and exhaust line from pump without removing vacuum assembly.

b. Attach one end of a 10" tygon tube (Moseley Part No. 387-0025) to exhaust side of pump. Using the syringe supplied in the accessory kit, half-fill the tubing with Isopropanol Alcohol (used for shellac thinning) and connect the tube to the pump intake. Turn power ON and allow alcohol to circulate for 10 seconds. Turn power OFF.

c. Disconnect intake tube and cover end with a cloth. Turn power ON and direct contaminated alcohol into the cloth.

d. Repeat procedure until alcohol remains clean. Should the pump fail completely, do not attempt to disassemble as re-assembly is difficult. Check all hose connections, lines, and filter for leakage or obstructions. If the trouble is definitely traced to the pump and the above procedure fails to correct, return to the factory for repair or exchange.

4-27. VACUUM FILTER. Clean or replace the filter periodically. The frequency required will depend on atmospheric conditions. To clean the filter, wash with clear luke warm water.

4-28. PUMP MOTOR. No motor maintenance is required. The V-belt should be checked occasionally for deterioration or cracks.

## 4-29. RESTRINGING INSTRUCTIONS

4-30. DISASSEMBLY. To restring the Y-axis, the recording platen must be removed. When restringing the X-axis, in addition to the recording platen, the amplifier section must also be removed.

4-31. MATERIALS REQUIRED. Before attempting to restring the recorder, the following materials should be available.

a. Seven strand steel stringing cable, 1/64" diameter Moseley Part No. 294-0001 (9 ft. length).

b. Cable crimps, Moseley Part No. 380-0115 (4 each).

c. Two (2) drive belts, Moseley Part No. 209-0001-3.

d. Nylon cable assembly, Moseley Part No. A-7856.

## 4-32. X-AXIS RESTRINGING PROCEDURE
(Refer to Figure 4-8)

a. Position the Y-carriage assembly at a convenient location and fasten securely with tape or clamps to prevent movement. Remove old cable.

b. Make a small loop in one end of a 54 inch length of cable and clinch with a cable clamp.

c. Attach the loop to the left arm of the tension spring, Point A. String the cable to the front of the right arm (Point B), then to idler pulley C. Continue around the idler pulley to the drive sheave, Point D.

d. Make three loops around the drive sheave in a counter clock-wise direction proceeding from the inboard edge to the outboard.

e. Continue to tension spring point G on the bottom of the Y-carriage assembly.

f. Make sure there is no cable crossover around Sheave D then fasten with a cable clamp to Point G.

NOTE: For proper alignment, the Y carriage assembly should be perpendicular to the front flange of the recorder prior to clamping the cable at Terminal G.

g. Make a small loop in a second piece of drive cable at least 50 inches long and fasten with a cable clamp.

h. Attach the loop to the right arm of the tension spring, Point B. String the cable in front of the left arm, Point A, to idler pulley I. Continue around pulley I to pulley H carrying over the first cable.

i. Continue around idler pulley H to tension spring point (F) on the bottom of the Y-carriage.

j. Fasten to spring G with a cable clamp.

## 4-33. Y-AXIS RESTRINGING PROCEDURE
(Refer to exploded view 5-5)

a. Replacement of the drive belt extending from the upper Y-carriage block to the center pulley of the pantograph assembly is self explanatory.

b. Replacement of the drive belt extending from the Y-axis motor drive pulley to the center of the pantograph arm is accomplished as follows:

(1) Unhook the drive belt from the center pulley of the pantograph assembly.

(2) Separate the inner and outer halfs of the arm connecting the two pulleys by sliding them apart. Do not lose internal spring.

(3) Remove the old cord and install a new one, reversing the above procedure.

## 4-34. Y-AXIS NYLON DRIVE CORD REPLACEMENT

a. Separate the carriage beam from the recorder (refer to paragraph 4-20) and the pen carriage from the carriage beam.

b. Install a new nylon drive cord assembly, consisting of a cable spring, cable hook, and nylon cord. (Moseley Part No. A-7856-4)

(1) Hook the free end of the tension spring to the stud on the pen carriage. Spring should pull toward the Y-drive pulley.

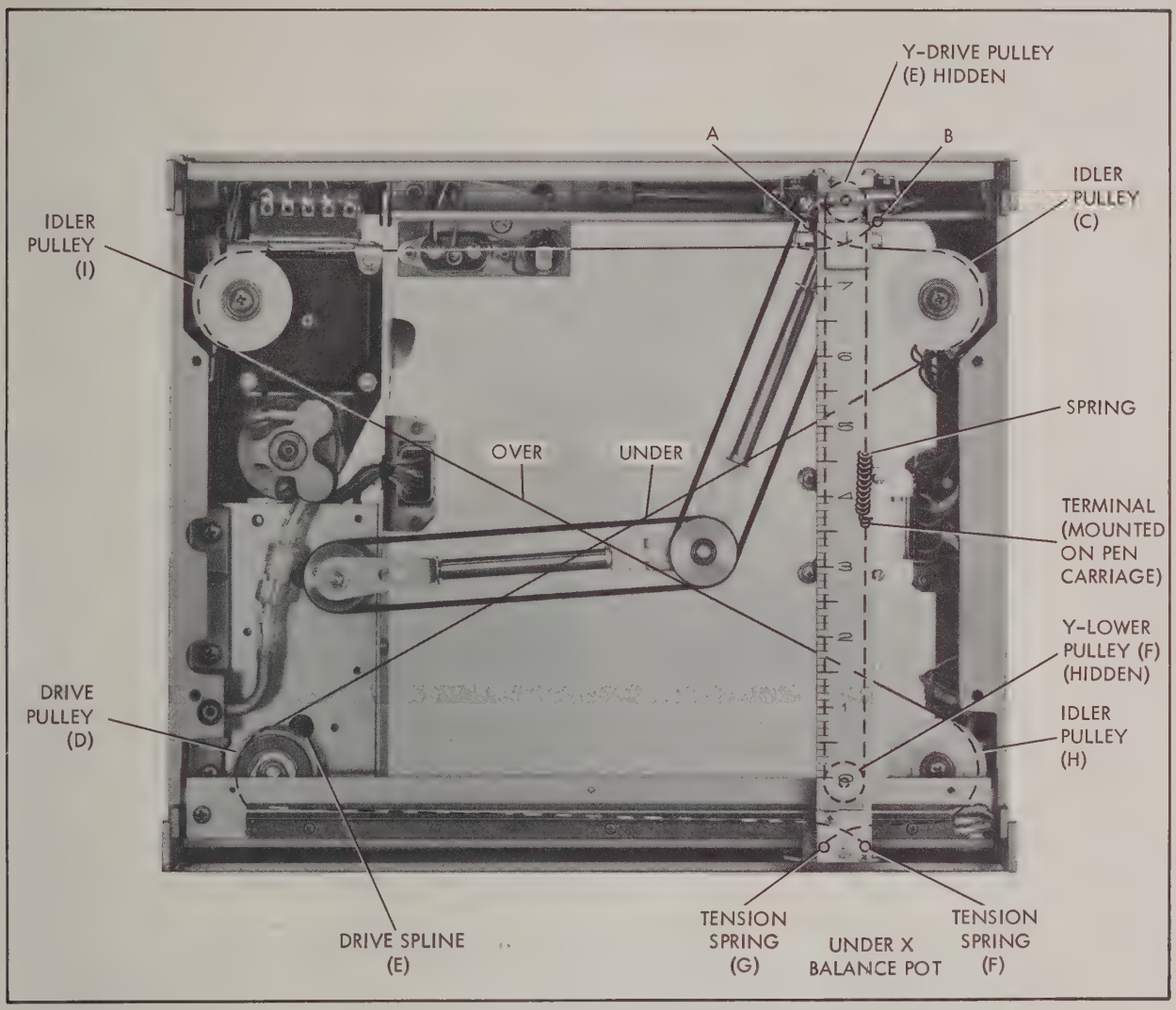



FIGURE 4-8. RESTRINGING DIAGRAM

(2) Loop the cord around the upper pulley and continue on around the lower pulley and back to the stud on the pen carriage.

(3) Attach the hooked end of the nylon cord to the pen carriage stud.

c: Replace the pen carriage and the carriage beam:

# SECTION V
# PARTS LIST

## MODEL 135, 135R PARTS LIST

This section lists all components on the schematic and items with mortality experience. Recommended spare parts for maintaining the instrument for a one year period are designated in column RS.

ORDERING: When ordering parts, the instrument TYPE and complete serial serial number should be included with the description as given in this section. To order a part not listed, describe the item, its location, and function. Orders and inquiries should be placed with your area field office, or sent directly to the factory addressed to:

CUSTOMER SERVICE
F. L. Moseley Co.,
409 N. Fair Oaks Ave.
Pasadena, California 91102

# SECTION V
# PARTS LIST

## MODEL 135, 135R PARTS LIST

| Circuit Symbol | Moseley Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| C-101 | 235-0008 | Capacitor, tantalum 3.6 mfd/60 v | Fansteel F-115 | 2 |
| C-102 | 235-0008 | Capacitor, tantalum 3.6 mfd/60 v | Fansteel F-115 | |
| C-103 | 235-0003 | Capacitor, tantalum 5 mfd/50 v | Fansteel PP5B50A1 | 4 |
| C-104 | 234-0042 | Capacitor, metalized .0047 mfd/200 v | Faradyne MFD 472K | 1 |
| C-105 | 234-0049 | Capacitor, metalized .05 mfd/600 v | Cornell-Doubilier WMF 6S5 | 1 |
| C-201 | 235-0008 | Capacitor, tantalum 3.6 mfd/60 v | Fansteel F-115 | |
| C-202 | 235-0008 | Capacitor, tantalum 3.6 mfd/60 v | Fansteel F-115 | |
| C-203 | 235-0003 | Capacitor, tantalum 5 mfd/50 v | Fansteel PP5B50A1 | |
| C-204 | 235-0007 | Capacitor, tantalum 30 mfd/6 v | Fansteel PP30B6A1 | 2 |
| C-205 | 235-0003 | Capacitor, tantalum 5 mfd/50 v | Fansteel PP5B50A1 | |
| C-206 | 234-0007 | Capacitor, metalized .01 mfd/200 v | Aerovox Type P83Z | |
| C-207 | 234-0041 | Capacitor, metalized .0068 mfd/200 v | Faradyne MFC 682K | 1 |
| C-208 | 234-0049 | Capacitor, metalized .05 mfd/600 v | Cornell-Doubilier WMF 6S5 | |
| C-301A, B | 233-0019 | Capacitor, paper .0022 mfd/100 v | C-D Miniroc STM1D22 | |
| C-302A, B | 231-0081 | Capacitor, electrolytic 30 mfd/6 v | Aerovox PWE-6030 | |
| C-303A, B | 231-0080 | Capacitor, electrolytic 4 mfd/12 v | Sprague TE-1123 | 4 |
| C-304A, B | 231-0080 | Capacitor, electrolytic 4 mfd/12 v | Sprague TE-1123 | |
| C-305A, B | 234-0037 | Capacitor, metalized .047 mfd/100 v | C-D WMF 1S47E | |
| C-306A, B | 231-0080 | Capacitor, electrolytic 4 mfd/12 v | Sprague TE-1123 | |
| C-307A, B | 231-0080 | Capacitor, electrolytic 4 mfd/12 v | Sprague TE-1123 | |
| C-308A, B | 231-0080 | Capacitor, electrolytic 4 mfd/12 v | Sprague TE-1123 | |
| C-309A, B | 231-0080 | Capacitor, electrolytic 4 mfd/12 v | Sprague TE-1123 | |
| C-311 | 234-0035 | Capacitor, metalized .1 mfd/100 v | C-D WMFIPIE | |
| C-312 | 234-0035 | Capacitor, metalized .1 mfd/100 v | C-D WMFIPIE | |
| C-313 | 231-0107 | Capacitor, electrolytic 30 mfd/150 v (NP) | Sprague | 1 |
| C-401 | 231-0073 | Capacitor, electrolytic 200 mfd/15 v | Sprague TE-1164 | |
| C-402 | 231-0073 | Capacitor, electrolytic 200 mfd/15 v | Sprague TE-1164 | |
| C-403 | 231-0066 | Capacitor, electrolytic 100 mfd/25 v | Sprague TE-1211 | |
| C-404 | 231-0066 | Capacitor, electrolytic 100 mfd/25 v | Sprague TE-1211 | |
| C-405 | 231-0009 | Capacitor, electrolytic 250 mfd/50 v | Sprague TVA-1312 | 1 |
| C-406 | 231-0067 | Capacitor, electrolytic 1500 mfd/50 v | Sprague TVL-1341 | 1 |
| C-407 | 234-0053 | Capacitor, electrolytic 1.5 mfd/400 v | Electrocube 210B-1 E155-K | |
| C-410 | 234-0030 | Capacitor, metalized 4 mfd/400 v | Electron D4-405 | |
| C-501 | 231-0066 | Capacitor, electrolytic 100 mfd/25 v | Sprague TE-1211 | |
| CH-101 | 221-0007 | Chopper | Stevens-Arnold BA-11-11 | 1 |
| CR-301 | 252-0025 | Diode, DI-54 | Diodes, Inc. | 4 |
| CR-302 | 252-0025 | Diode, DI-54 | Diodes, Inc. | |
| CR-401 | 252-0024 | Diode, zener | Texas Instr. IN 756 | 1 |

| Circuit Symbol | Moseley Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| CR-402 | 252-0024 | Diode, zener | Texas Instr. IN 756 | |
| CR-403 | 252-0017 | Diode, zener | International Rect. IN 1513 | 2 |
| CR-404 | 252-0017 | Diode, zener | International Rect. IN 1513 | |
| CR-405 | 252-0037 | Diode, SC-1 | Sem Tech | 2 |
| CR-406 | 252-0037 | Diode, SC-1 | Sem Tech | |
| CR-407 | 252-0037 | Diode, SC-1 | Sem Tech | |
| CR-408 | 252-0037 | Diode, SC-1 | Sem Tech | |
| CR-409 | 252-0032 | Diode, zener | Texas Instr. IN 253 | 2 |
| CR-410 | 252-0032 | Diode, zener | Texas Instr. IN 253 | |
| CR-411 | 252-0032 | Diode, zener | Texas Instr. IN 253 | |
| CR-412 | 252-0032 | Diode, zener | Texas Instr. IN 253 | |
| CR-413 | 252-0027 | Diode, zener | Int. Rect. IN 1594 | 2 |
| CR-414 | 254-0002 | Diode, zener | 4U1 | 1 |
| CR-501A, B | 252-0028 | Diode, zener | Hoffman IN 429 | 2 |
| CR-502A, B | 252-0017 | Diode, zener | Int. Rect. IN 1513 | |
| CR-503A, B | 252-0021 | Diode, T12G | Transitron | 2 |
| CR-504A, B | 252-0021 | Diode, T12G | Transitron | |
| F-101 | 331-0053 | Fuse, 2 amp. (115 v opn) | Bussman 3AG | 5 |
| F-101 | 331-0002 | Fuse, 1 amp. (230 v opn) | Bussman 3AG | 5 |
| J-101 | 316-0041 | Connector | Amphenol 57-20140 | |
| J-102 | 316-0041 | Connector | Amphenol 57-20140 | |
| J-103 | 316-0041 | Connector | Amphenol 57-20140 | |
| J-104 | 316-0041 | Connector | Amphenol 57-20140 | |
| J-105 | 316-0041 | Connector | Amphenol 57-20140 | |
| J-106 | 296-0007 | Power Cord (removable) | Beldon PH151/ CS9941/PH104/7.5 | 1 |
| J-109 | 346-0026 | Jack, remote pen Tini-Jax | Switchcraft #41 | 1 |
| J-110 | 316-0056 | Jack, rear input | Amphenol 126-198 | |
| K-401 | A-8695 | Pen Lift Solenoid | Moseley | 1 |
| M-301A | A-10475 | Servo Motor | Moseley | 1 |
| M-301B | A-10475 | Servo Motor | Moseley | |
| M-401 | D-12140 | Vacuum motor | Moseley | 1 |
| P-101 | 316-0047 | Connector | Amphenol 57-10140 | |
| P-102 | 316-0047 | Connector | Amphenol 57-10140 | |
| P-103 | 316-0047 | Connector | Amphenol 57-10140 | |
| P-104 | 316-0047 | Connector | Amphenol 57-10140 | |
| P-105 | 316-0047 | Connector | Amphenol 57-10140 | |
| P-106 | 319-0032 | Receptacle, power | Tower H-1061 IG | |
| R-101 | 243-0018 | Resistor, precision w. w., 1 K, .1% | Cinema 410E | 1 |
| R-102 | 243-0281 | Resistor, precision 2 K, .1% | Cinema 410E | 1 |
| R-103 | 243-0093 | Resistor, precision w. w., 6 K, 1/4 w, .1% | Cinema 410E | 1 |
| R-104 | 243-0026 | Resistor, precision w. w., 10 K, .1% | Cinema 410E | 1 |
| R-105 | 243-0090 | Resistor, precision w. w., 20 K, 1/4 w., 1% | Cinema 410E | 1 |
| R-106 | 243-0282 | Resistor, precision w. w., 60 K, .1% | Cinema 410E | 1 |
| R-107 | 243-0028 | Resistor, precision w. w., 100 K, .1% | Cinema 410E | 1 |
| R-108 | 243-0146 | Resistor, precision w. w., 200 K, .1% | Cinema 410E | 1 |
| R-109 | 243-0147 | Resistor, precision w. w., 600 K, .1% | Cinema 410E | 1 |
| R-110 | 243-0101 | Resistor, precision w. w., 1 meg, 1/2 w, .1% | Cinema 410E | 1 |
| R-113 | 243-0280 | Resistor, precision w. w., 999.5 ohm, .1% | Cinema 410E | 1 |
| R-114 | 243-0010 | Resistor, precision w. w., 249.87 ohm, .1% | Cinema 410E | 1 |
| R-115 | 243-0011 | Resistor, precision w. w., 111.06 ohm, .1% | Cinema 410E | 1 |
| R-116 | 243-0285 | Resistor, precision w. w., 52.61 ohm, .1% | Cinema 410E | 1 |
| R-117 | 243-0012 | Resistor, precision w. w., 20.39 ohm, .1% | Cinema 410E | 1 |
| R-118 | 241-0139 | Resistor, composition 510 ohm, 1/4 w, 5% | Allen-Bradley | |
| R-119 | 241-0138 | Resistor, composition 300 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-120 | 241-0137 | Resistor, composition 100 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-121 | 241-0136 | Resistor, composition 47 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-122 | 241-0135 | Resistor, composition 22 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-123 | 243-0018 | Resistor, precision w. w., 1 K, .1% | Cinema 410E | |
| R-124 | 241-0163 | Resistor, composition 2.7 K, 1/4 w, 10% | Allen-Bradley | |
| R-125 | 241-0164 | Resistor, composition 360 ohm, 1/4 w, 5% | Allen-Bradley | |
| R-126 | 236-0020 | Potentiometer, non-precision, 1 K | Allen-Bradley JU-1021 SDZ024 | 1 |

| Circuit Symbol | Moseley Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| R-127 | 241-0158 | Resistor, composition 470 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-128 | 241-0158 | Resistor, composition 470 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-129 | 241-0158 | Resistor, composition 470 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-130 | 241-0158 | Resistor, composition 470 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-131 | 243-0278 | Resistor, precision w. w., 1 K, 5% | Cinema 410E | 1 |
| R-132 | 242-0092 | Resistor, precision carbon, 1.1 meg, 1/8 w, 1% | Kay EM-60 | 1 |
| R-133 | 241-0211 | Resistor, composition 200 K, 1/4 w, 10% | Allen-Bradley | |
| R-134 | 241-0181 | Resistor, composition 390 K, 1/4 w, 10% | Allen-Bradley | |
| R-135 | 241-0182 | Resistor, composition 4.7 meg., 1/4 w, 10% | Allen-Bradley | |
| R-136A, B | 236-0047 | Potentiometer, non-precis. 5 K, Tandem, 10% dual shaft | Chicago Tel Co. Type C2-252 | 2 |
| R-137 | 243-0166 | Resistor, precision w. w., 1.3 K, 1% | Cinema 410E | 1 |
| R-138 | 236-0059 | Rheostat, non-precision 1000 ohms | Chicago Tel Co. #BK 12449 | 2 |
| R-139 | A-8694 | Y-axis slidewire 3.5 K | Moseley | 2 |
| R-201 | 243-0018 | Resistor, precision w. w., 1 K, .1% | Cinema 410E | |
| R-202 | 243-0281 | Resistor, precision 2K, .1% | Cinema 410E | |
| R-203 | 243-0093 | Resistor, precision w. w., 6 K, 1/4 w, .1% | Cinema 410E | |
| R-204 | 243-0026 | Resistor, precision w. w., 10 K, .1% | Cinema 410E | |
| R-205 | 243-0090 | Resistor, precision w. w., 20 K, 1/4 w, .1% | Cinema 410E | |
| R-206 | 243-0282 | Resistor, precision w. w., 60 K, .1% | Cinema 410E | |
| R-207 | 243-0028 | Resistor, precision w. w., 100 K, .1% | Cinema 410E | |
| R-208 | 243-0146 | Resistor, precision w. w., 200 K, .1% | Cinema 410E | |
| R-209 | 243-0147 | Resistor, precision w. w., 600 K, .1% | Cinema 410E | |
| R-210 | 243-0101 | Resistor, precision w. w., 1 meg, 1/2 w, .1% | Cinema 410E | |
| R-213 | 243-0280 | Resistor, precision w. w., 999.5 ohm, .1% | Cinema 410E | |
| R-214 | 243-0010 | Resistor, precision w. w., 249.87 ohm, .1% | Cinema 410E | |
| R-215 | 243-0011 | Resistor, precision w. w., 111.06 ohm, .1% | Cinema 410E | |
| R-216 | 243-0285 | Resistor, precision w. w., 52.61 ohm, .1% | Cinema 410E | |
| R-217 | 243-0012 | Resistor, precision w. w., 20.39 ohm, .1% | Cinema 410E | |
| R-218 | 241-0139 | Resistor, composition 510 ohm, 1/4 w, 5% | Allen-Bradley | |
| R-219 | 241-0138 | Resistor, composition 300 ohm, 1/4 w, 5% | Allen-Bradley | |
| R-220 | 241-0137 | Resistor, composition 100 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-221 | 241-0136 | Resistor, composition 47 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-222 | 241-0135 | Resistor, composition 22 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-223 | 243-0018 | Resistor, precision w. w., 1 K, .1% | Cinema 410E | |
| R-224 | 241-0163 | Resistor, composition 2.7 K, 1/4 w, 10% | Allen-Bradley | |
| R-225 | 241-0164 | Resistor, composition 360 ohm, 1/4 w, 5% | Allen-Bradley | |
| R-226 | 236-0020 | Potentiometer, non-precision, 1 K | Allen-Bradley JU-1021 SDZ024 | |
| R-227 | 241-0158 | Resistor, composition 470 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-228 | 241-0158 | Resistor, composition 470 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-229 | 241-0158 | Resistor, composition 470 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-230 | | Value selected at factory | | |
| R-231 | 241-0158 | Resistor, composition 470 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-232 | 241-0148 | Resistor, composition 3.3 K, 1/4 w, 10% | Allen-Bradley | |
| R-233 | 236-0059 | Rheostat, 1 K | Chicago Tel Co Type 110, #BK12449 | 2 |
| R-234 | 236-0059 | Rheostat, 1 K | Chicago Tel Co Type 110, #BK12449 | |
| R-235 | 236-0059 | Rheostat, 1 K | Chicago Tel Co Type 110, #BK12449 | |
| R-236 | 236-0059 | Rheostat, 1 K | Chicago Tel Co Type 110, #BK12449 | |
| R-237 | 236-0059 | Rheostat, 1 K | Chicago Tel Co Type 110, #BK12449 | |
| R-238 | 241-0158 | Resistor, composition 470 ohm, 1/4 w, 105 | Allen-Bradley | |
| R-239 | 242-0083 | Resistor, precision carbon, 12 K, 1/2 w, 1% | Aerovox CPS 1/2 | |
| R-240 | 241-0179 | Resistor, composition 240 K, 1/4 w, 10% | Allen-Bradley | |
| R-241 | | Value selected at factory | | |
| R-242 | | Value selected at factory | | |
| R-243 | 243-0278 | Resistor, precision w. w., 1 K, .05% | Cinema 410E | |
| R-244 | 241-0211 | Resistor, composition 56 K, 1/4 w, 10% | Allen-Bradley | |

| Circuit Symbol | Moseley Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| R-245 | 236-0065 | Potentiometer, non-precision, 100 K | Chicago Tel Co UPM-45 | |
| R-246 | 236-0065 | Potentiometer, non-precision, 100 K | Chicago Tel Co UPM-45 | |
| R-247 | 241-0148 | Resistor, composition 3.3 K, 1/4 w, 10% | Allen-Bradley | |
| R-248 | 241-0167 | Resistor, composition 39 K, 1/4 w, 10% | Allen-Bradley | |
| R-249A, B | 236-0047 | Potentiometer, non-precision, 5 K, Tandem, 10%, dual shaft | Chicago Tel Co Type C2-252 | |
| R-250 | 241-0169 | Resistor, composition 560 K, 1/4 w, 10% | Allen-Bradley | |
| R-251 | 241-0239 | Resistor, composition 200 K, 1/4 w, 10% | Allen-Bradley | |
| R-252 | 242-0091 | Resistor, precision carbon, 760 K, 1/8 w, 1% | Key EM-60 | |
| R-253 | 236-0059 | Rheostat, non-precision 1000 ohms | Chicago Tel Co #BK12449 | |
| R-254 | 243-0352 | Resistor, precision w. w., 2.6 K, 1% | Cinema 410E | |
| R-255 | 241-0180 | Resistor, composition 3.9 K, 1/4 w, 10% | Allen-Bradley | |
| R-256 | A-8704 | X-axis slidewire, 5 K | Moseley | 2 |
| R-257 | 241-0145 | Resistor, composition 1 K, 1/4 w, 10% | Allen-Bradley | |
| R-258 | 241-0145 | Resistor, composition 1 K, 1/4 w, 10% | Allen-Bradley | |
| R-301A, B | 241-0144 | Resistor, composition 820 K, 1/4 w, 10% | Allen-Bradley | |
| R-302A, B | 241-0149 | Resistor, composition 22 K, 1/4 w, 10% | Allen-Bradley | |
| R-303A, B | 241-0185 | Resistor, composition 5.6 K, 1/4 w, 10% | Allen-Bradley | |
| R-304A, B | 241-0209 | Resistor, composition 33 K, 1/4 w, 10% | Allen-Bradley | |
| R-305A, B | 241-0209 | Resistor, composition 33 K, 1/4 w, 10% | Allen-Bradley | |
| R-306A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-307A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-308A, B | 241-0186 | Resistor, composition 220 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-309A, B | 241-0186 | Resistor, composition 220 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-310 | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-311A, B | 236-0074 | Potentiometer, non-precision, 1 K | I. R. C. RQ 11-108 | |
| R-312A, B | 241-0209 | Resistor, composition 33 K, 1/4 w, 10% | Allen-Bradley | |
| R-313A, B | 241-0209 | Resistor, composition 33 K, 1/4 w, 10% | Allen-Bradley | |
| R-314A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-315A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-318A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-319A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-320A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-321A, B | 241-0210 | Resistor, composition 100 K, 1/4 w, 10% | Allen-Bradley | |
| R-322A, B | 241-0145 | Resistor, composition 1 K, 1/4 w, 10% | Allen-Bradley | |
| R-323A, B | 241-0210 | Resistor, composition 100 K, 1/4 w, 10% | Allen-Bradley | |
| R-324A, B | 241-0136 | Resistor, composition 47 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-325A, B | 241-0136 | Resistor, composition 47 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-326A, B | 240-0052 | Resistor, non-precision w. w., 1 ohm, 3 w | Sprague 151E | |
| R-327A, B | 240-0052 | Resistor, non-precision w. w., 1 ohm, 3 w | Sprague 151E | |
| R-401 | 241-0068 | Resistor, composition 330 ohm, 1/2 w, 10% | Allen-Bradley | |
| R-402 | 241-0068 | Resistor, composition 330 ohm, 1/2 w, 10% | Allen-Bradley | |
| R-403 | 241-0005 | Resistor, composition 22 ohm, 1/2 w, 10% | Allen-Bradley | |
| R-404 | 241-0005 | Resistor, composition 22 ohm, 1/2 w, 10% | Allen-Bradley | |
| R-405 | 241-0189 | Resistor, composition 120 ohm, 1/2 w, 10% | Allen-Bradley | |
| R-406 | 241-0189 | Resistor, composition 120 ohm, 1/2 w, 10% | Allen-Bradley | |
| R-407 | 240-0023 | Resistor, non-precision w. w., 270 ohm, 3 w, 5% | Sprague 151E | |
| R-408 | 240-0064 | Resistor, non-precision w. w., 75 ohm, 5 w | Sprague 243E | |
| R-410 | 240-0020 | Resistor, composition 100 ohm, 3 w, 5% | Allen-Bradley | |
| R-501A, B | 241-0158 | Resistor, composition 470 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-502A, B | 241-0096 | Resistor, composition 270 ohm, 1/2 w, 5% | Allen-Bradley | |
| T-301A, B | 204-0027 | Transformer, input | Triad G40638 | 1 |
| T-302A, B | 204-0028 | Transformer, transistor | Microtran MT11-FB | 1 |
| T-401 | 202-0039 | Transformer, power | Triad | 1 |
| T-501 | 204-0026 | Transformer, reference | Topaz 00837 | 1 |
| TR-301A, B | 256-0055 | Transistor | Texas Instr. 2N508A | 2 |
| TR-302A, B | 256-0055 | Transistor | Texas Instr. 2N508A | |
| TR-303A, B | 256-0022 | Transistor | Texas Instr. 2N1370 | 2 |
| TR-304A, B | 256-0022 | Transistor | Texas Instr. 2N1370 | |
| TR-305A, B | 256-0022 | Transistor | Texas Instr. 2N1370 | |
| TR-306A, B | 256-0022 | Transistor | Texas Instr. 2N1370 | |
| TR-307A, B | 256-0053 | Transistor | Moseley | 2 |
| TR-308A, B | 256-0053 | Transistor | Moseley | |

| Circuit Symbol | Moseley Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| S-101 | A-8712 | Switch, Y-function | Moseley | |
| S-102 | A-8709 | Switch, Y-attenuator | Moseley | |
| S-103 | 261-0037 | Switch, slide Fixed-variable, DPDT | Hewlett-Pkd 3101-0033 | 2 |
| S-201 | A-8708 | Switch, X-attenuator | Moseley | |
| S-202 | A-8710 | Switch, X-function | Moseley | |
| S-203 | 261-0037 | Switch, slide Fixed-variable, DPDT | Hewlett-Pkd 3101-0033 | |
| S-204 | 262-0053 | Switch, lever | Switchcraft | 1 |
| S-205 | 261-0035 | Switch, toggle 4 pole - 3 position | Carling IG 283-72X MOS2 | 1 |
| S-206 | 261-0037 | Switch, slide PW conversion, DPDT | Hewlett-Pkd 3101-0033 | |
| V-301A, B | 251-0030 | Tube, vacuum Nuvistor | R. C. A. 7586 | 2 |

"A" suffix refers to X axis "B" suffix refers to Y axis

## MODEL 135M, 135MR PARTS LIST

The 135M, 135MR parts list is identical to the 135, 135R parts list, with the following changes:

| Circuit Symbol | Moseley Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| R-101 | 243-0386 | Resistor, precision w. w., 1.5 K, 0.1% | Cinema 410E | 1 |
| R-102 | 243-0159 | Resistor, precision w. w., 2.5 K | Cinema 410E | 1 |
| R-103 | 243-0075 | Resistor, precision w. w., 5 K | Cinema 410E | 1 |
| R-104 | 243-0318 | Resistor, precision w. w., 15 K | Cinema 410E | 1 |
| R-105 | 243-0317 | Resistor, precision w. w., 25 K | Cinema 410E | 1 |
| R-106 | 243-0316 | Resistor, precision w. w., 50 K | Cinema 410E | 1 |
| R-107 | 243-0315 | Resistor, precision w. w., 150 K | Cinema 410E | 1 |
| R-108 | 243-0314 | Resistor, precision w. w., 250 K | Cinema 410E | 1 |
| R-109 | 243-0283 | Resistor, precision w. w., 500 K | Cinema 410E | 1 |
| R-110 | 243-0383 | Resistor, precision w. w., 1.5 meg. | Cinema 410E | 1 |
| R-111 | 243-0384 | Resistor, precision w. w., 999.5 ohm | Cinema 410E | 1 |
| R-112 | 243-0384 | Resistor, precision w. w., 333.19 ohm | Cinema 410E | 1 |
| R-113 | 243-0011 | Resistor, precision w. w., 111.06 ohm | Cinema 410E | 1 |
| R-114 | 243-0285 | Resistor, precision w. w., 52.61 ohm | Cinema 410E | 1 |
| R-115 | 243-0385 | Resistor, precision w. w., 25.61 ohm | Cinema 410E | 1 |
| R-116 | Deleted | ---- | | |
| R-117 | Deleted | ---- | | |
| R-119 | 241-0186 | Resistor, composition 220 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-120 | 241-0283 | Resistor, composition 150 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-201 | 243-0386 | Resistor, precision w. w., 1.5 K, 0.1% | Cinema 410E | |
| R-202 | 243-0159 | Resistor, precision w. w., 2.5 K, 0.1% | Cinema 410E | |
| R-203 | 243-0075 | Resistor, precision w. w., 5 K, 0.1% | Cinema 410E | |
| R-204 | 243-0318 | Resistor, precision w. w., 15 K, 0.1% | Cinema 410E | |
| R-205 | 243-0317 | Resistor, precision w. w., 25 K, 0.1% | Cinema 410E | |
| R-206 | 243-0316 | Resistor, precision w. w., 50 K, 0.1% | Cinema 410E | |
| R-207 | 243-0315 | Resistor, precision w. w., 150 K, 0.1% | Cinema 410E | |
| R-208 | 243-0314 | Resistor, precision w. w., 250 K, 0.1% | Cinema 410E | |
| R-209 | 243-0283 | Resistor, precision w. w., 500 K, 0.1% | Cinema 410E | |
| R-210 | 243-0383 | Resistor, precision w. w., 1.5 meg., 0.1% | Cinema 410E | |
| R-211 | 243-0280 | Resistor, precision w. w., 999.5 ohm | Cinema 410E | |
| R-212 | 243-0384 | Resistor, precision w. w., 333.19 ohm, 0.1% | Cinema 410E | |
| R-213 | 243-0011 | Resistor, precision w. w., 111.06 ohm, 0.1% | Cinema 410E | |
| R-214 | 243-0285 | Resistor, precision w. w., 52.61 ohm, 0.1% | Cinema 410E | |
| R-215 | 243-0385 | Resistor, precision w. w., 25.63 ohm, 0.1% | Cinema 410E | |
| R-216 | Deleted | ---- | | |
| R-217 | Deleted | ---- | | |
| R-219 | 241-0186 | Resistor, composition 220 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-220 | 241-0283 | Resistor, composition 150 ohm, 1/4 w, 10% | Allen-Bradley | |

| Circuit Symbol | Moseley Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| C-101 | 234-0049 | Capacitor, metalized, 0.05 mfd, 600 v | Cornell-Doubilier WMF6SR | |
| C-102 | 234-0039 | Capacitor, metalized, 0.015 mfd, 200 v | Faradyne MFC 153M | |
| C-103 | 238-0022 | Capacitor, ceramic, 0.05 mfd, 100 v | ECN 2143 | |
| C-201 | 234-0049 | Capacitor, metalized, 0.05 mfd, 600 v | Cornell-Doubilier WMF6S5 | |
| C-202 | 235-0003 | Capacitor, tantalum 5 mfd, 50 v | Fansteel PP5B50A1 | |
| C-203 | 235-0007 | Capacitor, tantalum 30 mfd, 6 v | Fansteel PP30B6A1 | 2 |
| C-204 | 234-0039 | Capacitor, metalized 0.015 mfd, 200 v | Faradyne MFC 153M | 2 |
| C-205 | 238-0022 | Capacitor, ceramic 0.05 mfd, 100 v | ECN 2143 | |
| C-206 | 234-0039 | Capacitor, metalized 0.015 mfd, 200 v | Faradyne MFC 153M | |
| C-201A, B | 233-0019 | Capacitor, paper 0.0022 mfd, 100 v | CD Miniros STM1D22 | |
| C-302A, B | 231-0097 | Capacitor, electrolytic 30 mfd, 6 v | Sprague TE-1138 | |
| C-303A, B | 231-0080 | Capacitor, electrolytic 4 mfd, 12 v | Sprague TE-1123 | 2 |
| C-304A, B | 231-0080 | Capacitor, electrolytic 4 mfd, 12 v | Sprague TE-1123 | |
| C-305A, B | 234-0037 | Capacitor, metalized 0.047 mfd, 100 v | C-D WMF1S41E | |
| C-306A, B | 231-0080 | Capacitor, electrolytic 4 mfd, 12 v | Sprague TE-1123 | |
| C-307A, B | 231-0080 | Capacitor, electrolytic 4 mfd, 12 v | Sprague TE-1123 | |
| C-308A, B | 231-0080 | Capacitor, electrolytic 4 mfd, 12 v | Sprague TE-1123 | |
| C-309A, B | 231-0080 | Capacitor, electrolytic 4 mfd, 12 v | Sprague TE-1123 | |
| C-311A, B | 234-0035 | Capacitor, metalized 0.1 mfd, 100 v | C-D WMFIPIE | |
| C-312A, B | 234-0035 | Capacitor, metalized 0.1 mfd, 100 v | C-D WMFIPIE | |
| C-313A, B | 231-0107 | Capacitor, electrolytic 30 mfd, 150 v | Aerovox E-26D585 | |
| C-351A, B | 231-0080 | Capacitor, electrolytic 4 mfd, 12 v | Sprague TE-1123 | |
| C-352A, B | 231-0089 | Capacitor, electrolytic 10 mfd, 6 v | Sprague TE-1087 | |
| C-401 | 231-0073 | Capacitor, electrolytic 200 mfd, 15 v | Sprague TE-1167 | |
| C-402 | 231-0073 | Capacitor, electrolytic 200 mfd, 15 v | Sprague TE-1164 | |
| C-403 | 231-0066 | Capacitor, electrolytic 100 mfd, 25 v | Sprague TE-1211 | |
| C-404 | 231-0066 | Capacitor, electrolytic 100 mfd, 25 v | Sprague TE-1211 | |
| C-405 | 231-0009 | Capacitor, electrolytic 250 mfd, 50 v | Sprague TVA-1312 | |
| C-406 | 231-0067 | Capacitor, electrolytic 1500 mfd, 50 v | Mallory WP068 | |
| C-407 | 234-0053 | Capacitor, metalized 1.5 mfd, 400 v | Electrocube 210B-1E155K | |
| C-410 | 234-0043 | Capacitor, metalized 4 mfd, 400 v, 3% | Electron D4-405 | |
| C-501A, B | 231-0066 | Capacitor, electrolytic 100 mfd, 25 v | Sprague TE-1211 | |
| CH-101 | 221-0007 | Chopper | Stevens-Arnold BA-11-11 | 1 |
| CR-301A, B | 252-0025 | Diode | Diodes, Inc. DI-54 | 4 |
| CR-302A, B | 252-0025 | Diode | Diodes, Inc. DI-54 | |
| CR-401 | 252-0024 | Diode | Texas Instr. IN 756 | 2 |
| CR-402 | 252-0024 | Diode | Texas Instr. IN 756 | |
| CR-403 | 252-0017 | Diode, zener | Int. Rect. IN 1513 | 2 |
| CR-404 | 252-0017 | Diode, zener | Int. Rect. IN 1513 | |
| CR-405 | 252-0037 | Diode | Semtech SC-1 | 4 |
| CR-406 | 252-0037 | Diode | Semtech SC-1 | |
| CR-407 | 252-0037 | Diode | Semtech SC-1 | |
| CR-408 | 252-0037 | Diode | Semtech SC-1 | |
| CR-409 | 252-0032 | Diode | Texas Instr. IN 253 | 2 |
| CR-410 | 252-0032 | Diode | Texas Instr. IN 253 | |
| CR-411 | 252-0032 | Diode | Texas Instr. IN 253 | |
| CR-412 | 252-0032 | Diode | Texas Instr. IN 253 | |
| CR-413 | 250-0018 | Diode, zener | Unitrobe UZ818 | 1 |
| CR-414 | 252-0024 | Diode, zener | Texas Instr. IN 756 | 2 |
| CR-415 | 252-0024 | Diode, zener | Texas Instr. IN 756 | |
| CR-416 | 254-0002 | Diode, zener | Int. Rect. 4U1 | 1 |
| CR-501A, B | 252-0028 | Diode, zener | Hoffman IN 429 | 1 |
| CR-502A, B | 252-0017 | Diode, zener | IRC IN 1513 | |
| CR-503A, B | 252-0021 | Diode | Transitron T12G | 2 |
| CR-504A, B | 252-0021 | Diode | Transitron T12G | |
| F-101 | 331-0002 | Fuse, 1A for 230 | Bussman 3AG | 5 |
| | 331-0053 | Fuse, 2A for 115 | Bussman 3AG | 5 |
| J-101 | 316-0041 | Connector | Amphenol 57-20140 | |
| J-102 | 316-0041 | Connector | Amphenol 57-20140 | |

| Circuit Symbol | Moseley Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| J-103 | 316-0041 | Connector | Amphenol 57-20140 | |
| J-104 | 316-0054 | Connector | Amphenol 57-20240 | |
| J-105 | 316-0041 | Connector | Amphenol 57-20140 | |
| J-106 | 296-0007 | Power Cord, removable | Beldon PH151/CS9941 | 1 |
| J-107 | 312-0024 | Terminal, input, red | HP G10E | 2 |
| J-108 | 312-0025 | Terminal, input, black | HP G10F | 2 |
| J-109 | 312-0005 | Terminal, input, ground | BP-10, 5/8 | 2 |
| J-110 | A-10442 | Connector, 7 pin | Moseley | |
| J-111 | 312-0024 | Terminal, input, red | HP G10E/w 938F | |
| J-112 | 312-0025 | Terminal, input, black | HP G10F | |
| J-113 | 346-0026 | Jack, remote control | Switchcraft 41 | |
| K-401 | A8695 | Pen Lift Solenoid | Moseley | 1 |
| M-301A, B | A-10475 | Servo Motor | Moseley | 2 |
| M-401 | D-12140 | Vacuum Pump Motor | Moseley | 1 |
| P-101 | 316-0047 | Connector | Amphenol 57-10140 | |
| P-102 | 316-0047 | Connector | Amphenol 57-10140 | |
| P-103 | 316-0047 | Connector | Amphenol 57-10140 | |
| P-104 | 316-0055 | Connector | Amphenol 57-10240 | |
| P-105 | 316-0047 | Connector | Amphenol 57-10140 | |
| P-106 | 319-0032 | Receptacle, power | Tower, H-1061 IG | |
| R-101 | 243-0410 | Resistor, precision w. w., 990 K, , 0.1% | Cinema 410E | 1 |
| R-102 | 243-0411 | Resistor, precision w. w., 9.9 K, , 0.1% | Cinema 410E | 1<br>1 |
| R-103 | 241-0146 | Resistor, composition 10K, 1/4 w, 10% | Allen-Bradley | 1 |
| R-104 | 243-0029 | Resistor, precision w. w., 100 ohms, , 0.1% | Cinema 410E | 1 |
| R-105 | 243-0075 | Resistor, precision w. w., 5 K, , 0.1% | Cinema 410E | 1 |
| R-106 | 243-0088 | Resistor, precision w. w., 4 K, , 0.1% | Cinema 410E | 1 |
| R-107 | 243-0148 | Resistor, precision w. w., 500 ohm, , 0.1% | Cinema 410E | 1 |
| R-108 | 243-0148 | Resistor, precision w. w., 500 ohm, , 0.1% | Cinema 410E | 1 |
| R-109 | 241-0265 | Resistor, composition 27 K, 1/4 w, 10% | Allen-Bradley | |
| R-110 | 241-0211 | Resistor, composition 200 K, 1/4 w, 10% | Allen-Bradley | |
| R-111 | 241-0211 | Resistor, composition 200 K, 1/4 w, 10% | Allen-Bradley | |
| R-112 | 236-0073 | Resistor, variable 100 K | CTS UPE-70 | 1 |
| R-113 | 241-0194 | Resistor, composition 4.7 K, 1/4 w, 10% | Allen-Bradley | |
| R-114 | 243-0413 | Resistor, precision w. w., 345 K, , 1% | Cinema 410E | 1 |
| R-115 | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-116 | 243-0412 | Resistor, precision w. w., 1.5 K, , 1% | Cinema 410E | 1 |
| R-117 | 236-0059 | Resistor, variable 1 K | Chicago Tel 110, BK12449 | 1 |
| R-118 | 243-0179 | Resistor, precision w. w., 1 K, , 1% | Cinema 410E | 1 |
| R-119 | 243-0406 | Resistor, precision w. w., 300 ohm, , 1% | Cinema 410E | 1 |
| R-121 | 241-0210 | Resistor, composition 100 K, 1/4 w, 10% | Allen-Bradley | |
| R-123 | 243-0457 | Resistor, precision w. w., 6.8 K, , 1% | EP22 | |
| R-124 | 244-0037 | Resistor, variable 2.5 K | Clarostat #62 | 1 |
| R-139 | A-9694 | Resistor, variable 3.5 K | Moseley | 2 |
| R-201 | 243-0410 | Resistor, precision w. w., 990 K, , 0.1% | Cinema 410E | 1 |
| R-202 | 243-0411 | Resistor, precision w. w., 9.9 K, , 0.1% | Cinema 410E | 1 |
| R-203 | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-204 | 243-0029 | Resistor, precision w. w., 100 ohm, , 0.1% | Cinema 410E | 1 |
| R-205 | 241-0194 | Resistor, composition 4.7 K, 1/4 w, 10% | Allen-Bradley | |
| R-206 | 236-0073 | Resistor, variable 100 K | CTS UPE-70 | |
| R-207 | 243-0075 | Resistor, precision w. w., 5 K, , 0.1% | Cinema 410E | |
| R-208 | 243-0145 | Resistor, precision w. w., 500 ohm, , 0.1% | Cinema 410E | |
| R-209 | 243-0088 | Resistor, precision w. w., 4 K, , 0.1% | Cinema 410E | |
| R-210 | 243-0148 | Resistor, precision w. w., 500 ohm, , 0.1% | Cinema 410E | |

| Circuit Symbol | Moseley Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| R-211 | 241-0211 | Resistor, composition 200 K, 1/4 w, 10% | Allen-Bradley | |
| R-212 | 241-0265 | Resistor, composition 27 K, 1/4 w, 10% | Allen-Bradley | |
| R-213 | 241-0211 | Resistor, composition 200 K, 1/4 w, 10% | Allen-Bradley | |
| R-214 | 241-0246 | Resistor, composition 56 K, 1/4 w, 5% | Allen-Bradley | |
| R-216 | 241-0148 | Resistor, composition 3.3 K, 1/4 w, 10% | Allen-Bradley | |
| R-218 | 244-0037 | Resistor, variable, 2.5 K | Clarostat #62 | |
| R-219 | 243-0457 | Resistor, precision w. w., 6.8 K, , 1% | EP22 | |
| R-220 | 241-0216 | Resistor, composition 680 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-221 | 242-0125 | Resistor, carbon 12.1 K, 1/2 w, 1% | Aerovox CPX 1/2 | |
| R-222 | 241-0177 | Resistor, composition 2.2 K, 1/4 w, 10% | Allen-Bradley | |
| R-223 | 236-0059 | Resistor, variable 1 K | Chicago Tel 110 BK12449 | |
| R-224 | 241-0216 | Resistor, composition 680 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-225 | 236-0059 | Resistor, variable 1 K | Chicago Tel 110 BK12449 | |
| R-226 | 241-0216 | Resistor, composition 680 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-227 | 236-0070 | Resistor, variable 500 ohm | Chicago Tel 110 BR12448 | |
| R-228 | 236-0073 | Resistor, variable 100 K | CTS UPE-70 | |
| R-229 | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-230 | 243-0409 | Resistor, precision w. w., 265 K, , 1% | Cinema 410E | |
| R-231 | 236-0059 | Resistor, variable 1 K | Chicago Tel 110 | |
| R-232 | 243-0406 | Resistor, precision w. w., 300 ohm, , 1% | Cinema 410E | |
| R-233 | 243-0412 | Resistor, precision w. w., 1.5 K, , 1% | Cinema 410E | |
| R-234 | 241-0163 | Resistor, composition 2.7 K, 1/4 w, 10% | Allen-Bradley | |
| R-235 | 243-0179 | Resistor, precision w. w., 1 K, , 1% | Cinema 410E | |
| R-236 | | Resistor, factory selected | | |
| R-237 | | Resistor, factory selected | | |
| R-238 | 241-0248 | Resistor, composition 62 K, 1/4 w, 5% | Allen-Bradley | |
| R-239 | 236-0073 | Resistor, variable 100 K | CTS UPE-70 | |
| R-256 | A-8704 | Resistor, variable 5 K | Moseley | 2 |
| R-301A, B | 241-0144 | Resistor, composition 820 K, 1/4 w, 10% | Allen-Bradley | |
| R-302A, B | 241-0149 | Resistor, composition 22 K, 1/4 w, 10% | Allen-Bradley | |
| R-303A, B | 241-0185 | Resistor, composition 5.6 K, 1/4 w, 10% | Allen-Bradley | |
| R-304A, B | 236-0082 | Resistor, variable 50 K | CTS UPE-70 | |
| R-305A, B | 241-0157 | Resistor, composition 47 K, 1/4 w, 10% | Allen-Bradley | |
| R-306A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-307A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-308A, B | 241-0145 | Resistor, composition 1 K, 1/4 w, 10% | Allen-Bradley | |
| R-309A, B | 241-0145 | Resistor, composition 1 K, 1/4 w, 10% | Allen-Bradley | |
| R-310A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-312A, B | 241-0209 | Resistor, composition 33 K, 1/4 w, 10% | Allen-Bradley | |
| R-313A, B | 241-0209 | Resistor, composition 33 K, 1/4 w, 10% | Allen-Bradley | |
| R-314A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-315A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-318A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-319A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-320A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-321A, B | 241-0210 | Resistor, composition 100 K, 1/4 w, 10% | Allen-Bradley | |
| R-322A, B | 241-0145 | Resistor, composition 1 K, 1/4 w, 10% | Allen-Bradley | |
| R-323A, B | 241-0210 | Resistor, composition 100 K, 1/4 w, 10% | Allen-Bradley | |
| R-324A, B | 241-0137 | Resistor, composition 100 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-325A, B | 241-0137 | Resistor, composition 100 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-326A, B | 240-0052 | Resistor, non-precision w. w., 1 ohm, 3 w | Sprague 242E | |
| R-327A, B | 240-0052 | Resistor, non-precision w. w., 1 ohm, 3 w | Sprague 242E | |
| R-351A, B | 241-0210 | Resistor, composition 100 K, 1/4 w, 10% | Allen-Bradley | |
| R-352A, B | 241-0160 | Resistor, composition 15 K, 1/4 w, 10% | Allen-Bradley | |
| R-353A, B | 241-0138 | Resistor, composition 300 ohm, 1/4 w, 5% | Allen-Bradley | |
| R-354A, B | 241-0209 | Resistor, composition 33 K, 1/4 w, 10% | Allen-Bradley | |
| R-355A, B | 241-0146 | Resistor, composition 10 K, 1/4 w, 10% | Allen-Bradley | |
| R-356A, B | 241-0137 | Resistor, composition 100 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-357A, B | 241-0137 | Resistor, composition 100 ohm, 1/4 w, 10% | Allen-Bradley | |
| R-401 | 241-0295 | Resistor, composition 750 ohm, 1/2 w, 5% | Allen-Bradley | |
| R-402 | 241-0295 | Resistor, composition 750 ohm, 1/2 w, 5% | Allen-Bradley | |
| R-403 | 241-0296 | Resistor, composition 120 ohm, 1/2 w, 5% | Allen-Bradley | |
| R-404 | 241-0296 | Resistor, composition 120 ohm, 1/2 w, 5% | Allen-Bradley | |

| Circuit Symbol | Moseley Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| R-405 | 241-0131 | Resistor, composition 82 ohm, 1/2 w, 5% | Allen-Bradley | |
| R-406 | 241-0131 | Resistor, composition 82 ohm, 1/2 w, 5% | Allen-Bradley | |
| R-407 | 240-0023 | Resistor, non-precision w. w., 270 ohm, 3 w | Sprague 242E | |
| R-408 | 240-0020 | Resistor, non-precision w. w., 100 ohm, 3 w, 5% | Sprague 242E-1015 | |
| R-410 | 240-0020 | Resistor, non-precision w. w., 100 ohm, 3 w, 5% | Sprague 242E-1015 | |
| R-414 | 241-0295 | Resistor, composition 750 ohm, 1/2 w, 5% | Allen-Bradley | |
| R-415 | 241-0295 | Resistor, composition 750 ohm, 1/2 w, 5% | Allen-Bradley | |
| R-501A, B | 241-0289 | Resistor, composition 470 ohm, 1/4 w, 5% | Allen-Bradley | |
| R-502A, B | 241-0096 | Resistor, composition 270 ohm, 1/2 w, 5% | Allen-Bradley | |
| T-301A, B | 204-0037 | Transformer, input | Triad G40658 | 1 |
| T-302A, B | 204-0028 | Transformer, transistor | Microtran MT 11-FB | 1 |
| T-401 | 202-0039 | Transformer, power | Triad 68476 | 1 |
| T-501 | 204-0026 | Transformer, reference | Topaz 00837 | 1 |
| TR-301A, B | 256-0055 | Transistor | G. E. 2N508A | 2 |
| TR-302A, B | 256-0055 | Transistor | G. E. 2N508A | |
| TR-303A, B | 256-0022 | Transistor | Texas Instr. 2N1370 | |
| TR-304A, B | 256-0022 | Transistor | Texas Instr. 2N1370 | 4 |
| TR-305A, B | 256-0022 | Transistor | Texas Instr. 2N1370 | |
| TR-306A, B | 256-0022 | Transistor | Texas Instr. 2N1370 | |
| TR-307A, B | 256-0053 | Transistor | Moseley | 2 |
| TR-308A, B | 256-0053 | Transistor | Moseley | 2 |
| TR-310A, B | 256-0027 | Transistor | Texas Instr. 2N1302 | 1 |
| S-101 | 262-0085 | Switch, range | CTS #52032 | 1 |
| S-102 | 261-0031 | Switch, slide (Fix-Var) | Muter 4603T | 2 |
| S-103 | A-12900 | Switch, function | Moseley | |
| S-201 | 262-0084 | Switch, range | CTS #52018 | |
| S-202 | A-12900 | Switch, function | Moseley | |
| S-203 | 261-0031 | Switch, slide (Fix-Var) | Muter 4603-T | |
| S-204 | 262-0053 | Switch, pen-time | Switchcraft 6S-1931A | 1 |
| S-205 | 261-0035 | Switch, vacuum-power | Carling TG283 72XMOS2 | 1 |
| S-206 | 261-0037 | Switch, slide, power conversion | HP 3101-0033 | 1 |
| V-301A | 251-0032 | Tube, nuvister | RCA A-15342 | 2 |

## MODEL 135AM, 135AMR PARTS LIST

The 135AM, 135AMR Parts List is the same as the 135A, 135AR with the following changes:

| Circuit Symbol | Moseley Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| R-105 | 243-0431 | Resistor, precision w. w., 7.5 K, , 0.1% | Cinema 410E | |
| R-106 | 243-0432 | Resistor, precision w. w., 3.75 K, , 0.1% | Cinema 410E | |
| R-107 | 243-0069 | Resistor, precision, w. w., 750K, , 0.1% | Cinema 410E | |
| R-109 | 241-0209 | Resistor, composition 33 K, 1/4 w, 10% | Allen-Bradley | |
| R-110 | 241-0147 | Resistor, composition 180 K, 1/4 w, 10% | Allen-Bradley | |
| R-111 | 241-0178 | Resistor, composition 300 K, 1/4 w, 10% | Allen-Bradley | |
| R-207 | 243-0431 | Resistor, precision w. w., 7.5 K, , 0.1% | Cinema 410E | |
| R-208 | 243-0069 | Resistor, precision w. w., 750 K, , 0.1% | Cinema 410E | |
| R-209 | 243-0432 | Resistor, precision w. w., 3.75 K, , 0.1% | Cinema 410E | |
| R-211 | 241-0178 | Resistor, composition 300 K, 1/4 w, 10% | Allen-Bradley | |
| R-212 | 241-0209 | Resistor, composition 33 K, 1/4 w, 10% | Allen-Bradley | |
| R-213 | 241-0147 | Resistor, composition 180 K, 1/4 w, 10% | Allen-Bradley | |

## MECHANICAL PARTS

Refer to Figure 5-1 through 5-8 for information regarding mechanical parts.

## MISCELLANEOUS ITEMS

Accessory Kit - A-8718

| Moseley Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|
| A-10844 | Filter, foam (1 each) | Moseley | 2 |
| A-9423 | Syringe (2 each) | Moseley | 2 |
| B-10282 | Pen (2 each) | Moseley | 2 |
| NPN | Wire, Piano, 0.004 dia. (1 ft) | | 5' |
| 209-0011 | Neoprene, gasket | Miller Gasket | 4 |
| 209-0017 | Gasket, syringe (2 each) | Bussman 3AG | 2 |
| 228-0006 | Graph paper (10 shts) | Gubelman | A/R |
| 228-0007 | Graph paper (10 shts) | Gubelman | A/R |
| 331-0053 | Fuse, 3AG, 2A (5 each) | | 5 |
| 333-0005 | Ink, red (1 bottle) | Esterline Angus | A/R |
| 333-0006 | Ink, green (1 bottle) | Esterline Angus | A/R |
| 333-0020 | Tip-syringe (1 each) | | 1 |
| 342-0007 | Dust Cover (1 each) | | |
| 346-0027 | "Tini-Plug", #750 | | 2 |
| 376-0005 | Wrench (1 each) | Bristol S060 | 1 |
| 376-0006 | Wrench (1 each) | Bristol S076-4 | 1 |
| 376-0007 | Wrench (1 each) | Bristol S094 | 1 |
| 376-0008 | Wrench (1 each) | Bristol S110 | 1 |
| 376-0009 | Wrench (1 each) | Bristol S048-4 | 1 |
| 376-0010 | Wrench (1 each) | Bristol 5114 | 1 |
| 387-0025 | Tubing, Tygon (10") | | 1' |
| 391-0001 | Slidewire, cleaner and lube (1 bottle) | Moseley | 2 |

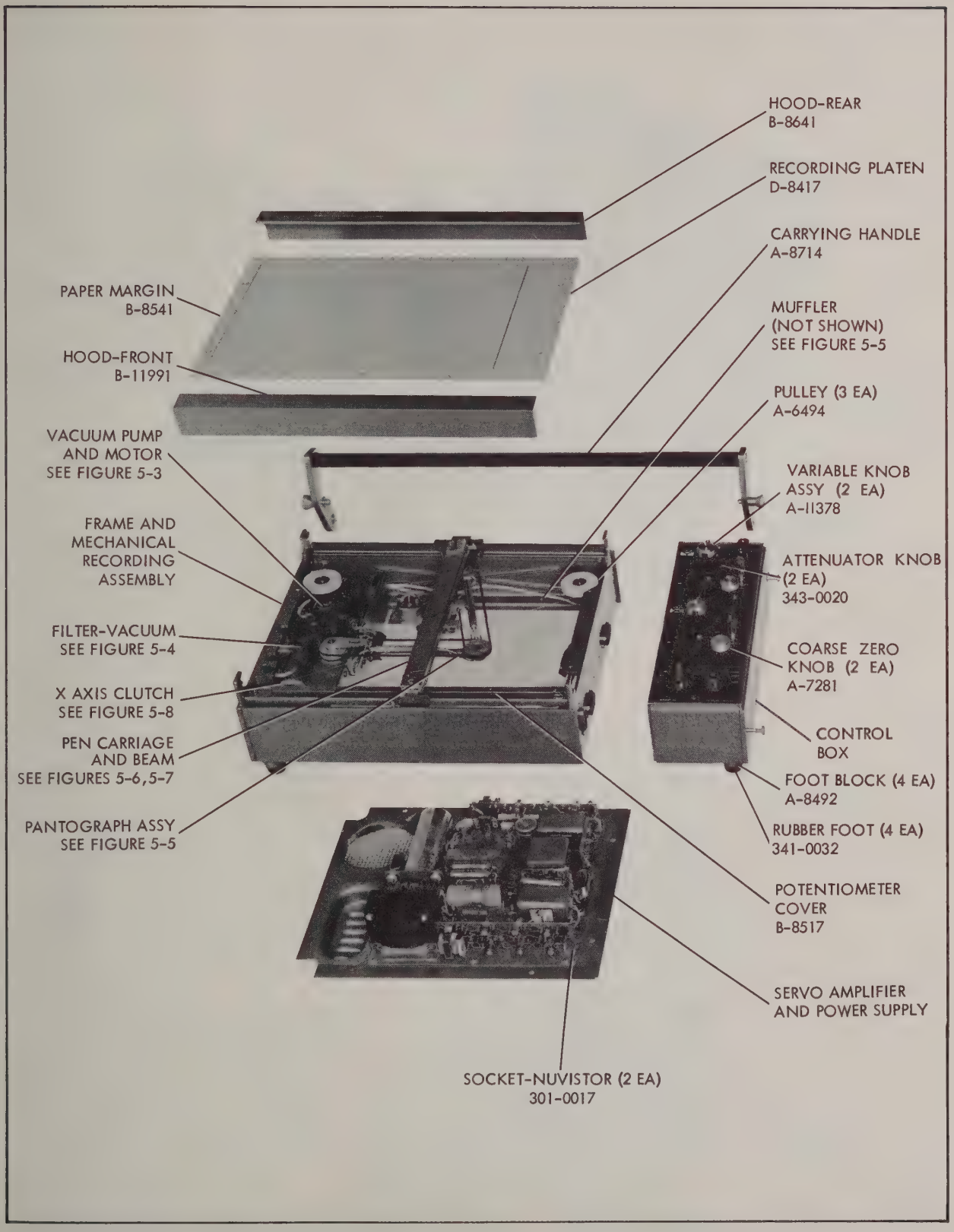
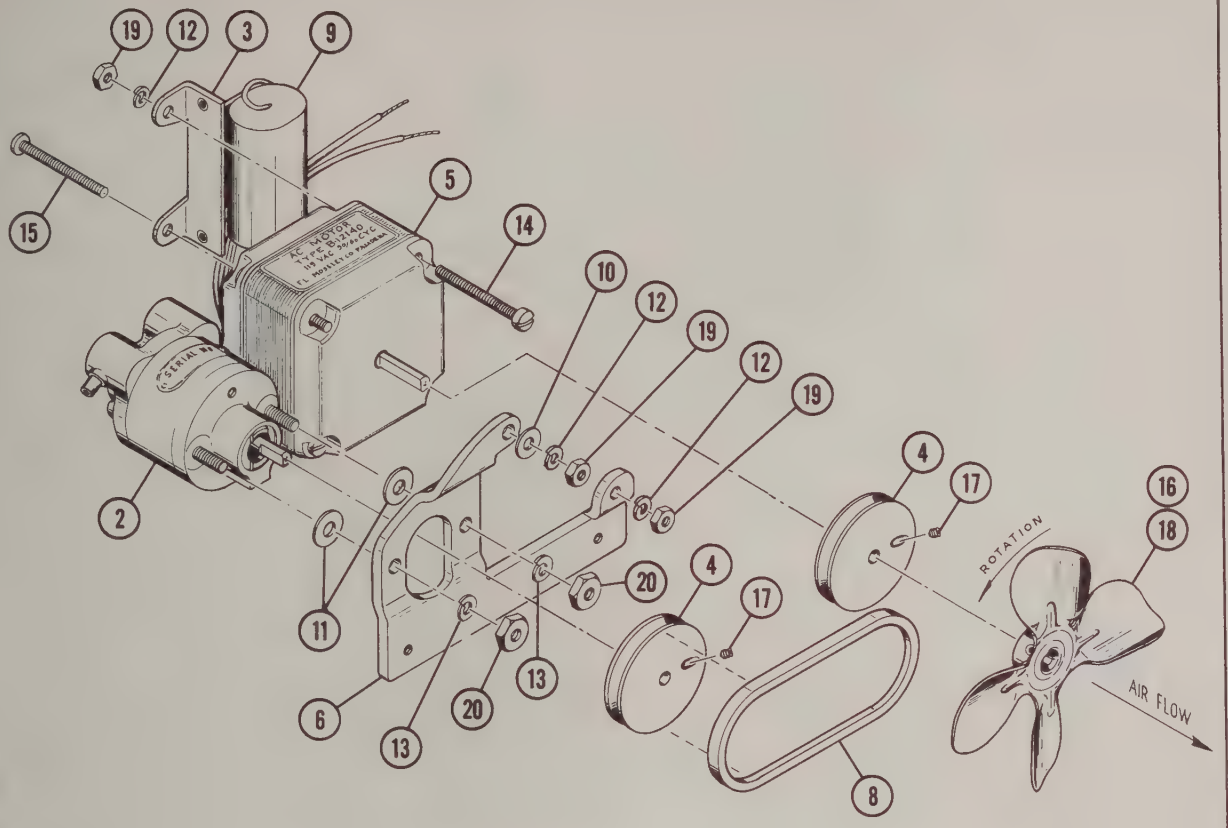
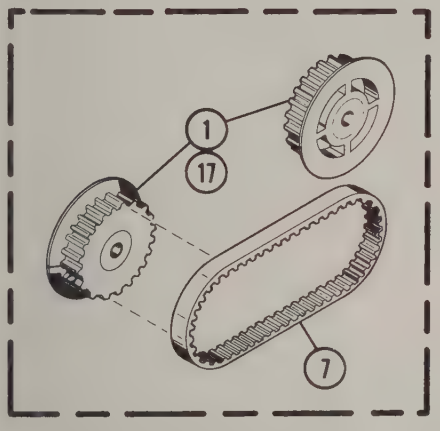



FIGURE 5-1. MECHANICAL COMPONENTS

| B/N | Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| 1 | A-9423 | Syringe (2 Each) | Moseley | 2 |
| | A-10844 | Filter, Foam (1 Each) | Moseley | 2 |
| 2 | B-10282 | Pen (2 Each) | Moseley | 2 |
| 3 | NPN | Wire, Piano, 0.004 Dia. (1 Ft) | Moseley | 5' |
| | 209-0011 | Neoprene, Gasket | Miller Gasket | 4 |
| | 209-0017 | Gasket, Syringe (2 Each) | | 2 |
| | 228-0006 | Graph Paper (10 Shts) | Gubelman | A/R |
| | 228-0007 | Graph Paper (10 Shts) | Gubelman | A/R |
| 4 | 331-0053 | Fuse, 3AG, 2A (5 Each) | Bussman 3AG | 5 |
| 5 | 333-0005 | Ink, Red (1 Bottle) | Esterline Angus | A/R |
| 6 | 333-0006 | Ink, Green (1 Bottle) | Esterline Angus | A/R |
| 7 | 333-0020 | Syringe-Less Tip | Moseley | 1 |
| | 342-0007 | Dust Cover (1 Each) | | |
| 8 | 346-0027 | "Tini-Plug", #750 | | 2 |
| 9 | 376-0005 | Wrench (1 Each) | Bristol S060 | 1 |
| | 376-0006 | Wrench (1 Each) | Bristol S076-4 | 1 |
| | 376-0007 | Wrench (1 Each) | Bristol S094 | 1 |
| | 376-0008 | Wrench (1 Each) | Bristol S110 | 1 |
| | 376-0009 | Wrench (1 Each) | Bristol S048-4 | 1 |
| | 376-0010 | Wrench (1 Each) | Bristol 5114 | 1 |
| 10 | 387-0025 | Tubing, Tygon (10") | | 1' |
| 11 | 391-0001 | Slidewire, Cleaner & Lube (1 Bottle) | Moseley | 2 |

FIGURE 5-2. ACCESSORY KIT

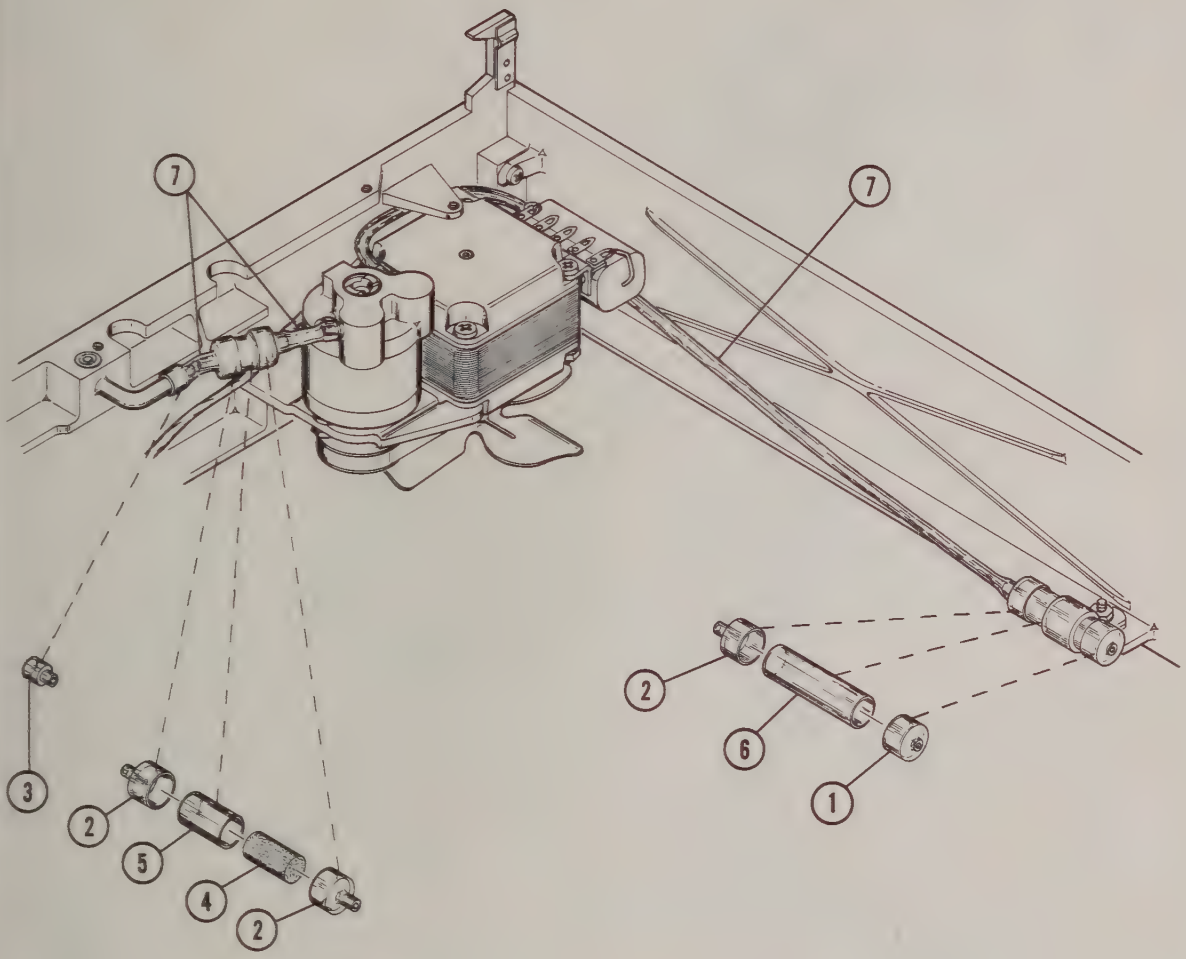


USED ON EARLIER MODELS

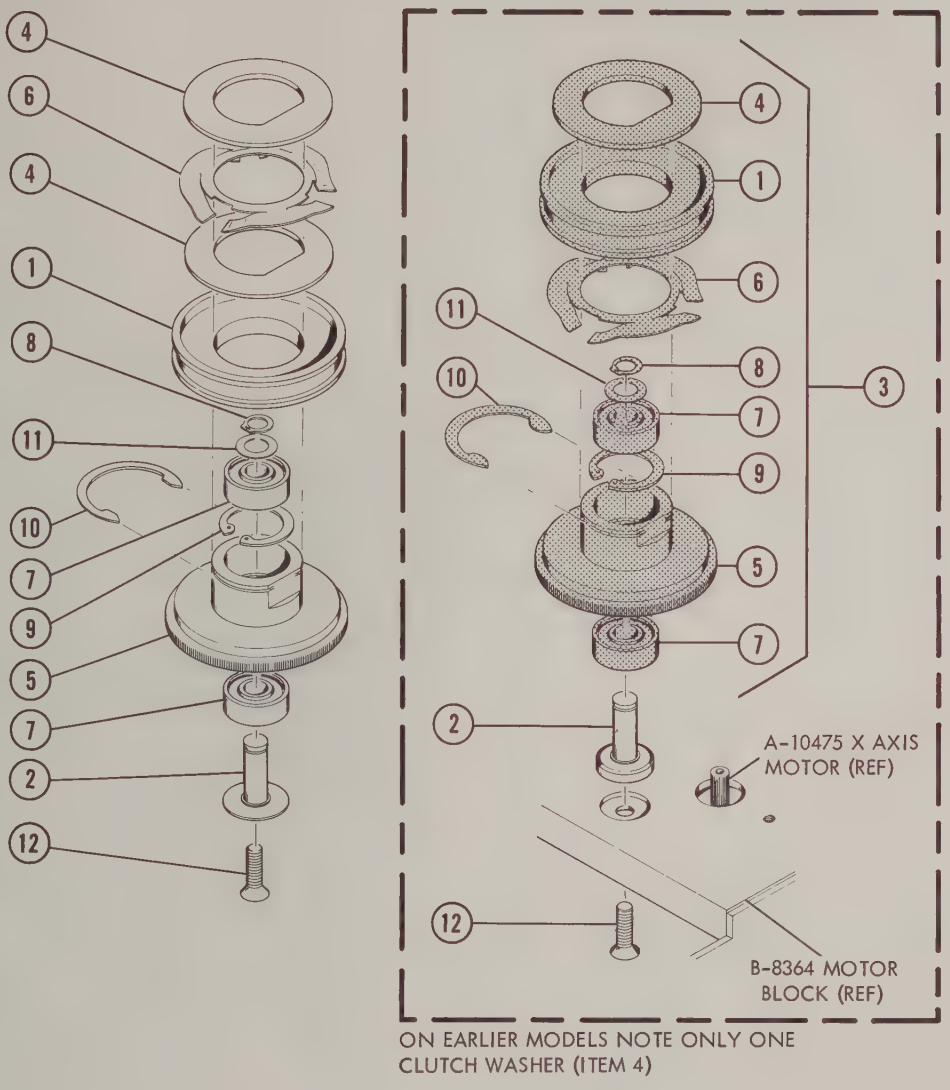
| B/N | Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| 1 | A-8666-2 | Pulley, Vacuum Pump | | |
| 2 | A-10621 | Assy, Vacuum Pump | | 2 |
| 3 | A-12446 | Assy, Terminal Mounting Bracket | | |
| 4 | A-13670 | Pulley, V-Belt | | |
| 5 | B-12140 | Motor | | 1 |
| 6 | C-12366 | Plate - Pump & Motor-Mounting | | |
| 7 | 209-0016 | Belt - Timing | | 1 |
| 8 | 209-0025 | V-Belt | | |
| 9 | 234-0053 | Capacitor 1.5/400 | | |
| 10 | 360-0032 | #8 Flat Washer | | |
| 11 | 360-0033 | #10 Flat Washer | | |
| 12 | 360-0062 | #8 Lock Washer | | |
| 13 | 360-0063 | #10 Lock Washer | | |
| 14 | 366-1015 | 8-32 x 1-3/8 PHMS | | |
| 15 | 366-1017 | 8-32 x 1-5/8 PHMS | | |
| 16 | 375-0030 | #10-32 x 3/16 Set Screw | Bristol | |
| 17 | 375-0031 | #8-32 x 3/16 Set Screw | Bristol | |
| 18 | 380-0156 | Fan Blade | | |
| 19 | 383-0008 | #8-32 Small Hex Nut | | |
| 20 | 383-0011 | #10-32 Hex Nut | | |

FIGURE 5-3. VACUUM PUMP (EXPLODED VIEW)



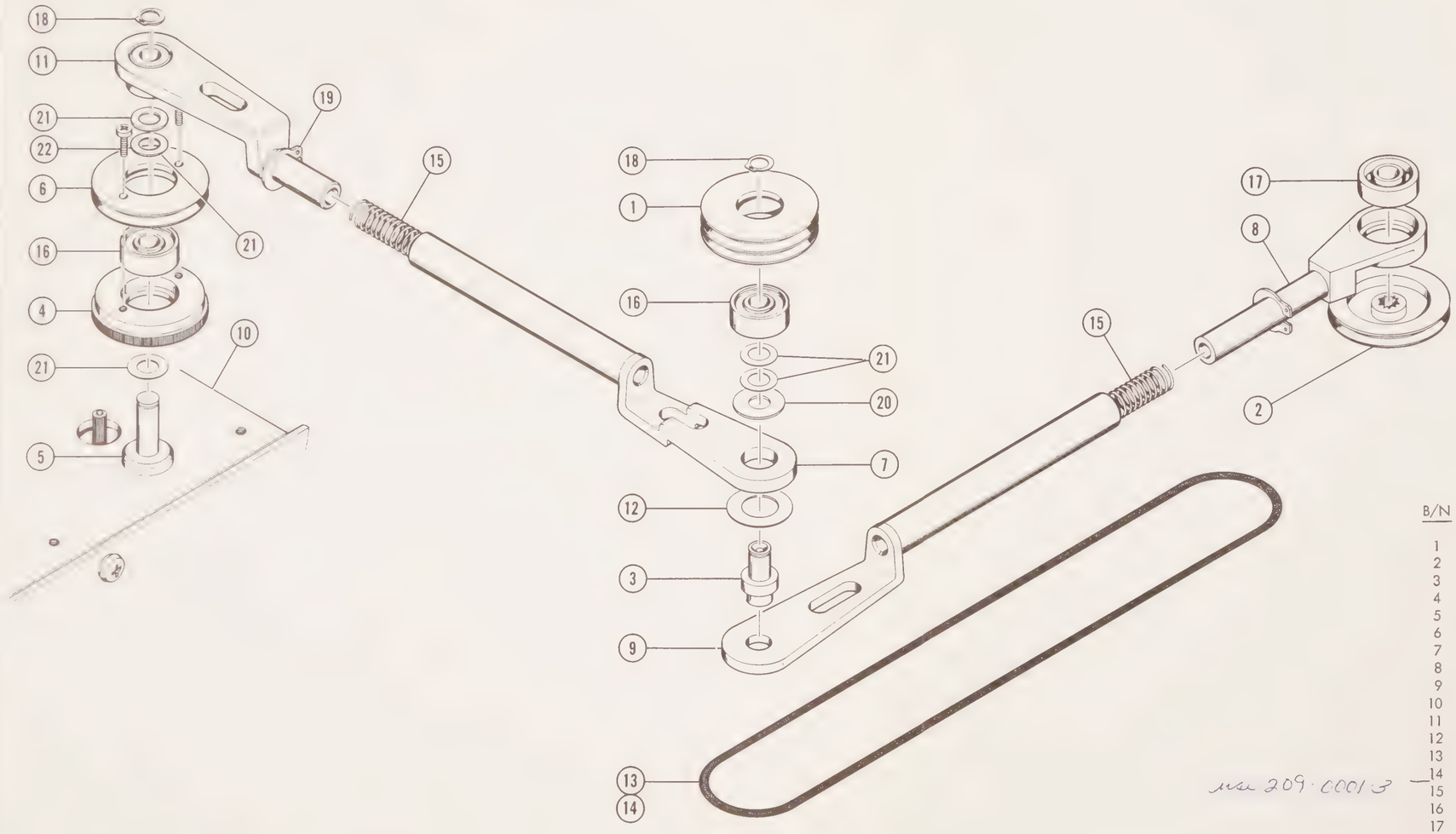

| B/N | Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| 1 | A-10712 | Outlet | Moseley | |
| 2 | A-10778 | Cap | Moseley | |
| 3 | A-10830 | Adapter | Moseley | |
| 4 | A-10844-2 | Foam, Filter | Moseley | 4 |
| 5 | A-10845 | Tube | Moseley | |
| 6 | A-10847 | Tube, Exhaust | Moseley | |
| 7 | 387-0025 | Tubing, Tygon | Moseley | 2 |

FIGURE 5-4. VACUUM SYSTEM (EXPLODED VIEW)




| B/N | Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| 1 | A-5964 | Sheave-Drive | Moseley | |
| 2 | A-6488 | Stud-Clutch | Moseley | |
| 3 | A-8956 | Complete Clutch Assy | Moseley | 1 |
| 4 | A-10275 | Washer-Clutch | Moseley | |
| 5 | B-10276 | Gear-Clutch | Moseley | |
| 6 | 355-0024 | Spring | Associated Spring #S-10 | |
| 7 | 356-0003 | Ball Bearing | MRC Type R3FF | |
| 8 | 357-0001 | Retaining Ring-External | Waldes Tru-Arc 5100-18 | |
| 9 | 357-0016 | Retaining Ring-Internal | Waldes #N5000-50 | |
| 10 | 357-0021 | Retaining Ring | | |
| 11 | 360-0090 | Shim 0.005, 3/16 ID X 5/16 OD | Moseley | |
| 12 | 367-0161 | Screw, Flat Hd, 6-32 | | |

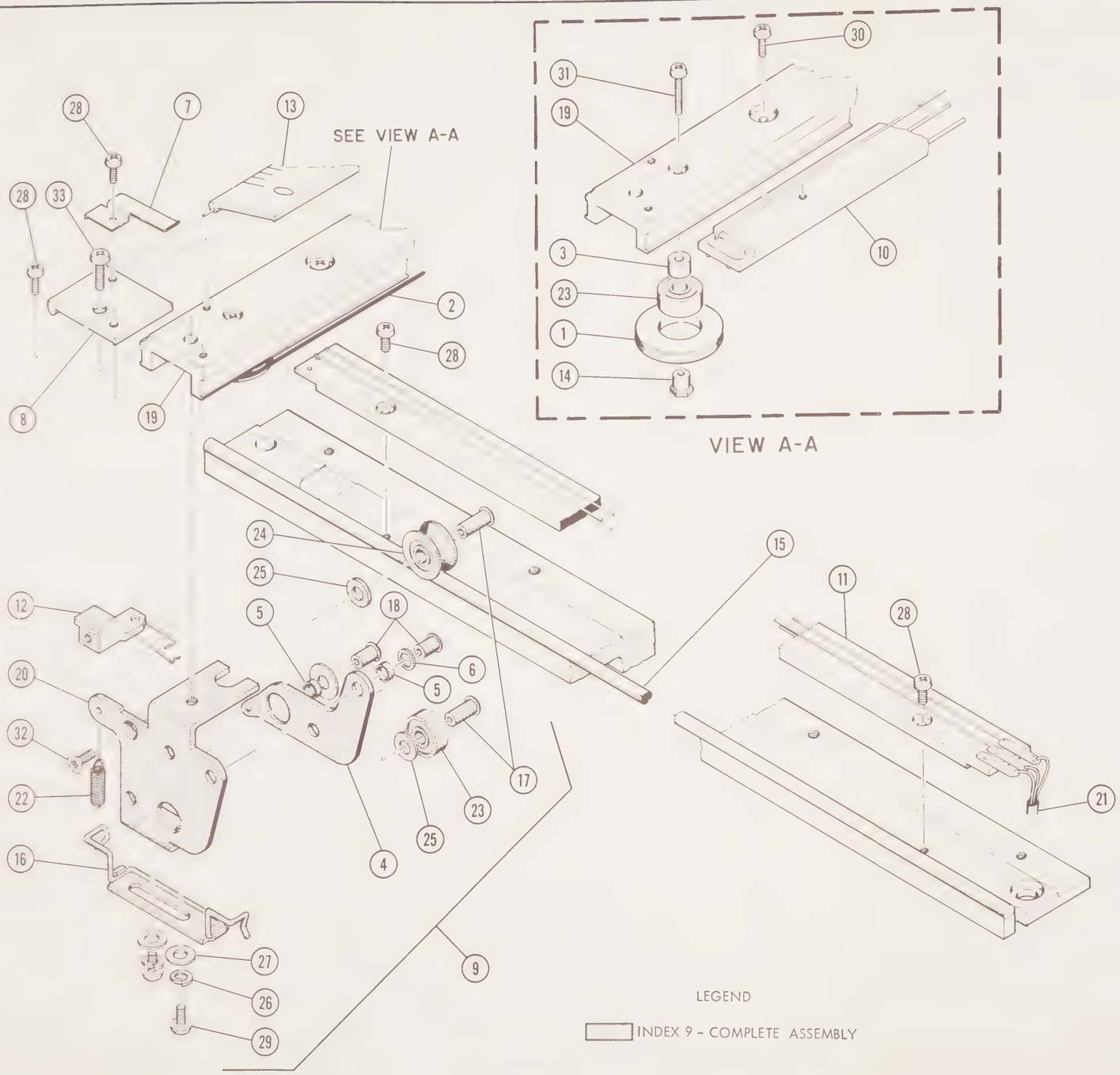
FIGURE 5-5. X AXIS SERVO DRIVE CLUTCH (EXPLODED VIEW)




| B/N | Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| 1 | A-1590 | Pulley, Double | Moseley | |
| 2 | A-1844C | Pulley | Moseley | |
| 3 | A-1950 | Bushing, Spacer Rod | Moseley | |
| 4 | A-2373 | Gear, Y Motor | Moseley | 1 |
| 5 | A-6496 | Terminal, Anchor | Moseley | |
| 6 | A-6497 | Pulley | Moseley | 1 |
| 7 | A-7099-2 | Arm, Pantograph | Moseley | |
| 8 | A-8425 | Arm, Pantograph | Moseley | |
| 9 | A-8427-2 | Hinge, Pantograph | Moseley | |
| 10 | A-8702 | Motor Block | Moseley | |
| 11 | A-8703 | Hinge, Pantograph | Moseley | |
| 12 | A-10257 | Washer | Moseley | |
| 13 | 209-0001-3 | Belt | S.S. White #104 | 2 |
| 14 | ~~209-0003~~ | Belt | Lewis Clark #104 | 2 |
| 15 | 355-0037 | Spring, Pantograph | Moseley | 2 |
| 16 | 356-0003 | Ball, Bearing | MRC Type R3FF | 2 |
| 17 | 356-0012 | Ball, Bearing | MRC R3 | 1 |
| 18 | 357-0001 | Retaining Ring | Waldes, Tru-Arc 5100-18 | 2 |
| 19 | 357-0024 | Retaining Ring | Waldes, Tru-Arc 5555-25MD | 2 |
| 20 | 360-0033 | Washer | | |
| 21 | 360-0092 | Washer | | |
| 22 | 366-0007 | Screw | | |

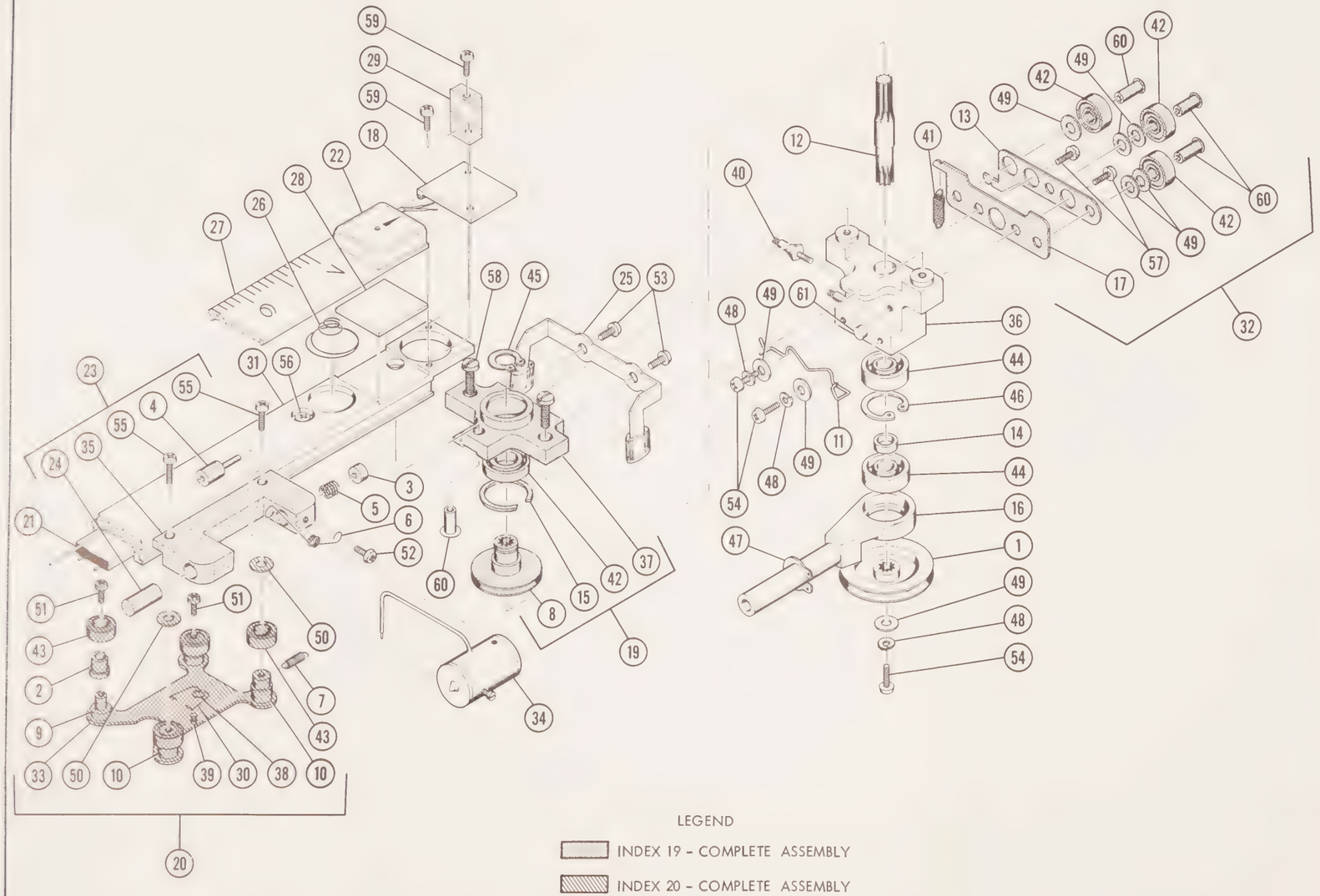
use 209-0001-3

FIGURE 5-6 PANTOGRAPH ARM
(EXPLODED VIEW)



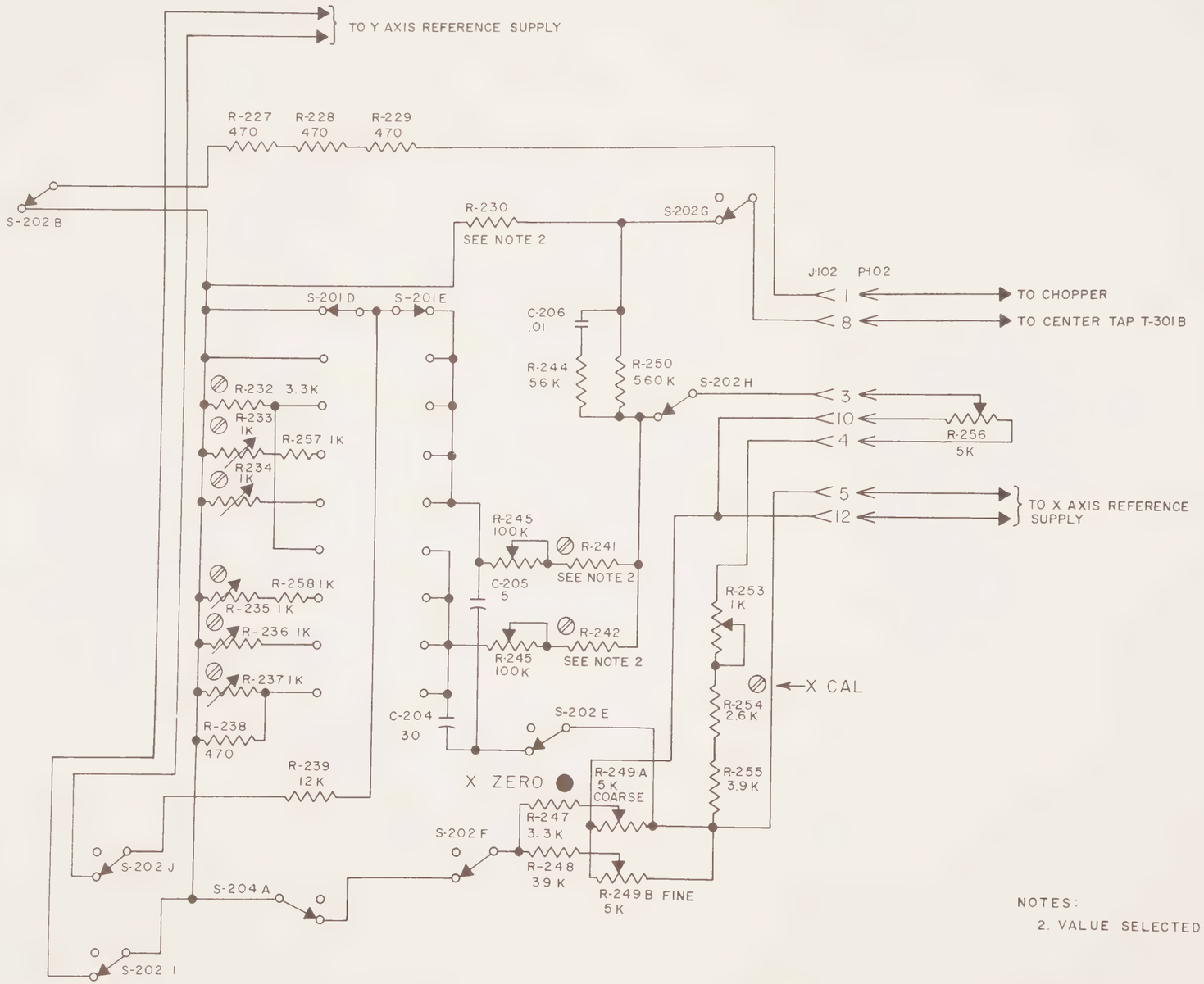

| B/N | Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| 1 | A-6458 | Pulley, Pen Cable | Moseley | |
| 2 | A-7856-4 | Nylon Cord Assy | Moseley | |
| 3 | A-8416 | Spacer | Moseley | |
| 4 | A-8507 | Bracket, Power Slider | Moseley | |
| 5 | A-8508-1 | Spacer | Moseley | |
| 6 | A-8508-2 | Spacer | Moseley | |
| 7 | A-8658 | Stop, Lower, Pen Lift | Moseley | 2 |
| 8 | A-8663 | Hinge, Lower, Pen Lift | Moseley | |
| 9 | A-8689 | Complete Slider Block Assy | Moseley | |
| 10 | A-8694 | Y Slidewire Assy | Moseley | 1 |
| 11 | A-8704 | X Slidewire Assy | Moseley | 1 |
| 12 | A-8870 | X Axis Wiper Assy | Moseley | 2 |
| 13 | A-10341 | Pen Scale | Moseley | |
| 14 | A-10889 | Nut, Retaining | Moseley | |
| 15 | A-12030 | Runner, Frame | Moseley | |
| 16 | A-12985 | X Axis Cable Retainer | Moseley | |
| 17 | A-13040-1 | Rivet | Moseley | |
| 18 | A-13040-2 | Rivet | Moseley | |
| 19 | B-8414 | Track, Y Axis | Moseley | |
| 20 | B-8506 | Lower, Slider Block | Moseley | |
| 21 | 293-0022 | Cable Assy | | |
| 22 | 355-0044 | Spring | Moseley | |
| 23 | 356-0004 | Ball Bearing | MRC Type #R2FF | |
| 24 | 356-0031 | Roller | Microtech MRD-5-RPP-Y | |
| 25 | 360-0030 | Washer, Flat #4 960-4 | | |
| 26 | 360-0040 | Washer, Lock #4 Split Type | | |
| 27 | 360-0400 | Washer, Flat, 1/4 OD x 0.125 ID, 1/64 Thick | | |
| 28 | 366-0001 | Screw, Binder Head, #2-56 | | |
| 29 | 366-0143 | Screw, Binder Head, #2-56 | | |
| 30 | 366-0200 | Screw, Binder Head, #3-48 x 1/8 | | |
| 31 | 366-0204 | Screw, Binder Head, #3-48 x 3/8 | | |
| 32 | 367-0053 | Screw, Flat Head, #2-56 | | |
| 33 | 370-0039 | Screw, Fillister Head, #6-32 x 5/16 | | |

FIGURE 5-7 LOWER CARRIAGE BEAM (EXPLODED VIEW)




| B/N | Part No. | Description | Mfr/Mfrs Designation | RS |
|---|---|---|---|---|
| 1 | A-1884C | Pulley | Moseley | |
| 2 | A-2091 | Eccentric Mounts | Moseley | |
| 3 | A-2848 | Cap, Spring | Moseley | |
| 4 | A-2850 | Plunger | Moseley | |
| 5 | A-2851 | Spring | Moseley | 2 |
| 6 | A-4457 | Spring-Pen Hold Down | Moseley | 2 |
| 7 | A-5961 | Spring (Part of Nylon Cord Assy) | Moseley | |
| 8 | A-6439B | Pulley-Y Drive | Moseley | |
| 9 | A-6478 | Shaft, Bearing | Moseley | |
| 10 | A-6479 | Standoff Bearing (Rear) | Moseley | |
| 11 | A-8394 | Bracket-X Axis Cable | Moseley | |
| 12 | A-8408 | Drive Shaft | Moseley | |
| 13 | A-8410 | Slider Adjustment Arm | Moseley | |
| 14 | A-8412-1 | Spacer | Moseley | |
| 15 | A-8416 | Retaining Ring | Moseley | |
| 16 | A-8425 | Pantograph Arm | Moseley | |
| 17 | A-8511 | Slider Bracket | Moseley | |
| 18 | A-8662 | Hinge-Upper Scale | Moseley | |
| 19 | A-8674 | Complete Upper Slider Block Assy (Half) | Moseley | 1 |
| 20 | A-8693 | Complete Pen Plate Assy | Moseley | 1 |
| 21 | A-8694 | Slidewire-Y Axis | Moseley | 2 |
| 22 | A-8695 | Solenoid-Pen Lift | Moseley | 2 |
| 23 | A-8696 | Complete Pen Block Assy | Moseley | 1 |
| 24 | A-9107 | Pin-Pen Mount | Moseley | |
| 25 | A-9307 | Stop-X Axis | Moseley | |
| 26 | A-9820 | Spring | Moseley | |
| 27 | A-10341 | Scale-Y Axis | Moseley | |
| 28 | A-10381 | Plate-Magnetic | Moseley | |
| 29 | A-11915 | Clamp-Wiring | Moseley | |
| 30 | B-6335 | Contact-Y Axis Slidewire | Moseley | 4 |
| 31 | B-8414 | Carriage Beam | Moseley | |
| 32 | B-8586 | Complete Slider Bracket Assy | Moseley | |
| 33 | B-8619 | Plate, Pen | Moseley | |
| 34 | B-10282 | Pen | Moseley | 2 |
| 35 | B-13013 | Block-Pen Mounting | Moseley | |
| 36 | C-10631 | Upper Slider Block (Half) | Moseley | |
| 37 | C-10633 | Upper Slider Block (Half) | Moseley | |
| 38 | 237-0002 | Ilet, 1/16 X 3/32 | Circon CE44 | |
| 39 | 312-0037 | Terminal | Lerco 5090B | |
| 40 | 312-0049 | Terminal | Lerco #6051 | |
| 41 | 355-0044 | Spring-Expansion | Moseley | 2 |
| 42 | 356-0004 | Ball Bearing | MRC Type #R2FF | 1 |
| 43 | 356-0011 | Ball Bearing | Microtech | |
| 44 | 356-0012 | Ball Bearing | MRC R-3 | 2 |
| 45 | 357-0003 | Retaining Ring-External (1/4 Shaft) | Waldes Tru-Arc-5100-25-C | |
| 46 | 357-0018 | Retaining Ring-Internal | Eaton NAN50 | |
| 47 | 357-0024 | Retaining Ring | Waldes #5555-25MD | |
| 48 | 360-0003 | Washer, Lock, #4 Internal Tooth | | |
| 49 | 360-0026 | Washer, Flat #4, 1/64 Thk | | |
| 50 | 360-0030 | Washer, Flat #4, 960-4 | | |
| 51 | 366-0001 | Screw, Binder Hd, 2-56, Cad Plated | | |
| 52 | 366-0002 | Screw, Binder Hd, 2-56, Cad Plated | | |
| 53 | 366-0413 | Screw, Binder Hd, 4-40 X 3/16, (Small) | | |
| 54 | 366-0414 | Screw, Binder Hd, 4-40 X 1/4 | | |
| 55 | 366-0415 | Screw, Binder Hd, 4-40 X 5/16 | | |
| 56 | 367-0002 | Screw, Flat Head, 2-56 | | |
| 57 | 370-0006 | Screw, Fil Hd, 4-40 X 3/16 | | |
| 58 | 370-0039 | Screw, Fil Hd, 6-32 X 5/16 | | |
| 59 | 370-0051 | Screw, Pan Hd, 2-56 X 3/16 | | |
| 60 | 378-0232 | Rivet, 1/8 Dia X 5/16 | Chicago R-3472-5/16 | |
| 61 | 380-0069 | Pin-Spirol, 1/16 Dia X 1/4 | Stainless 302 | |

FIGURE 5-8 UPPER CARRIAGE BEAM (EXPLODED VIEW)




NOTES:

2. VALUE SELECTED AT FACTORY

| | |
|---|---|
| TIME SWEEP CIRCUIT<br>MODEL: 135 | C-14348 |

FIGURE 5-9. TIME BASE CIRCUIT (135)

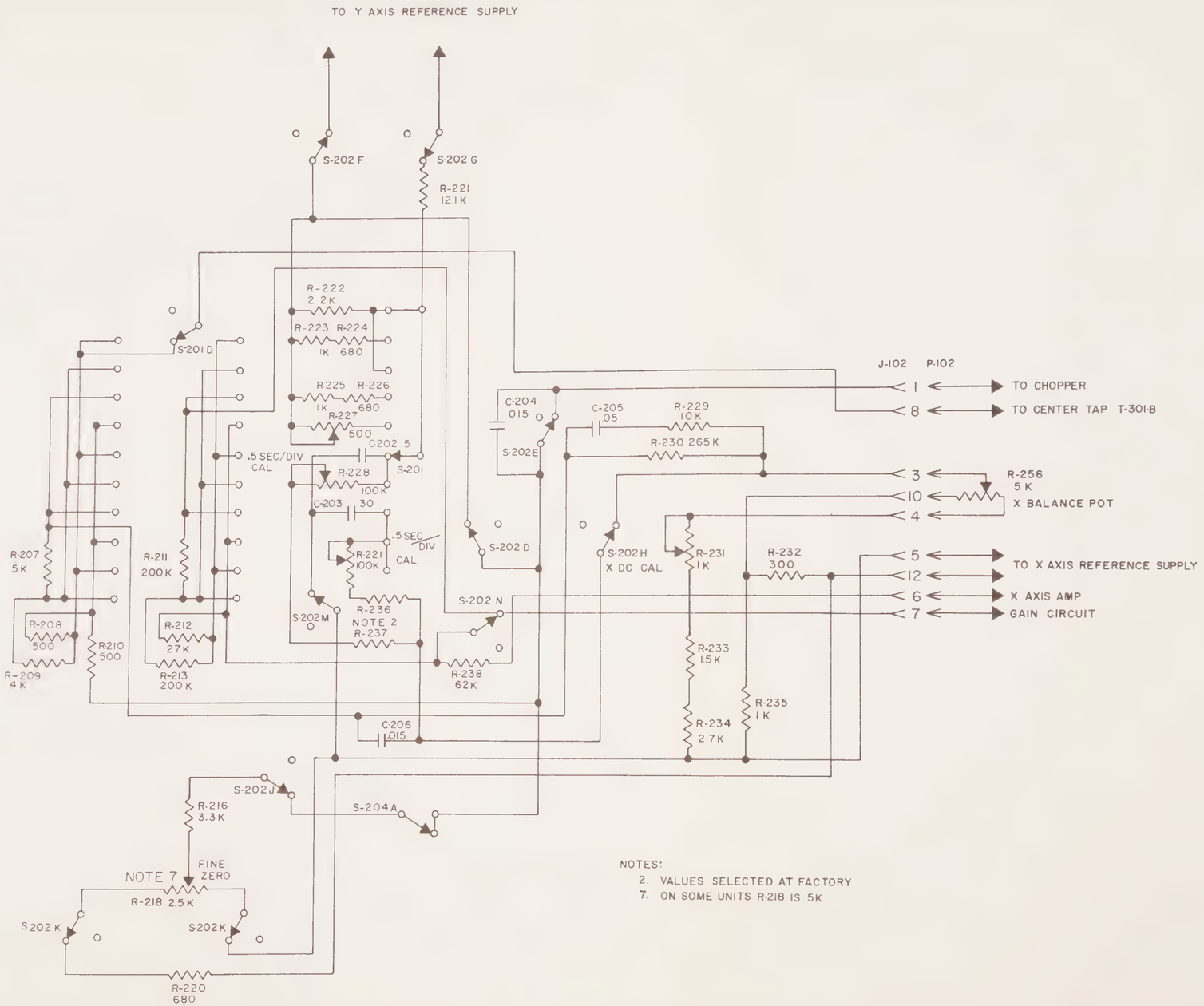



FIGURE 5-10. TIME BASE CIRCUIT (135 A)

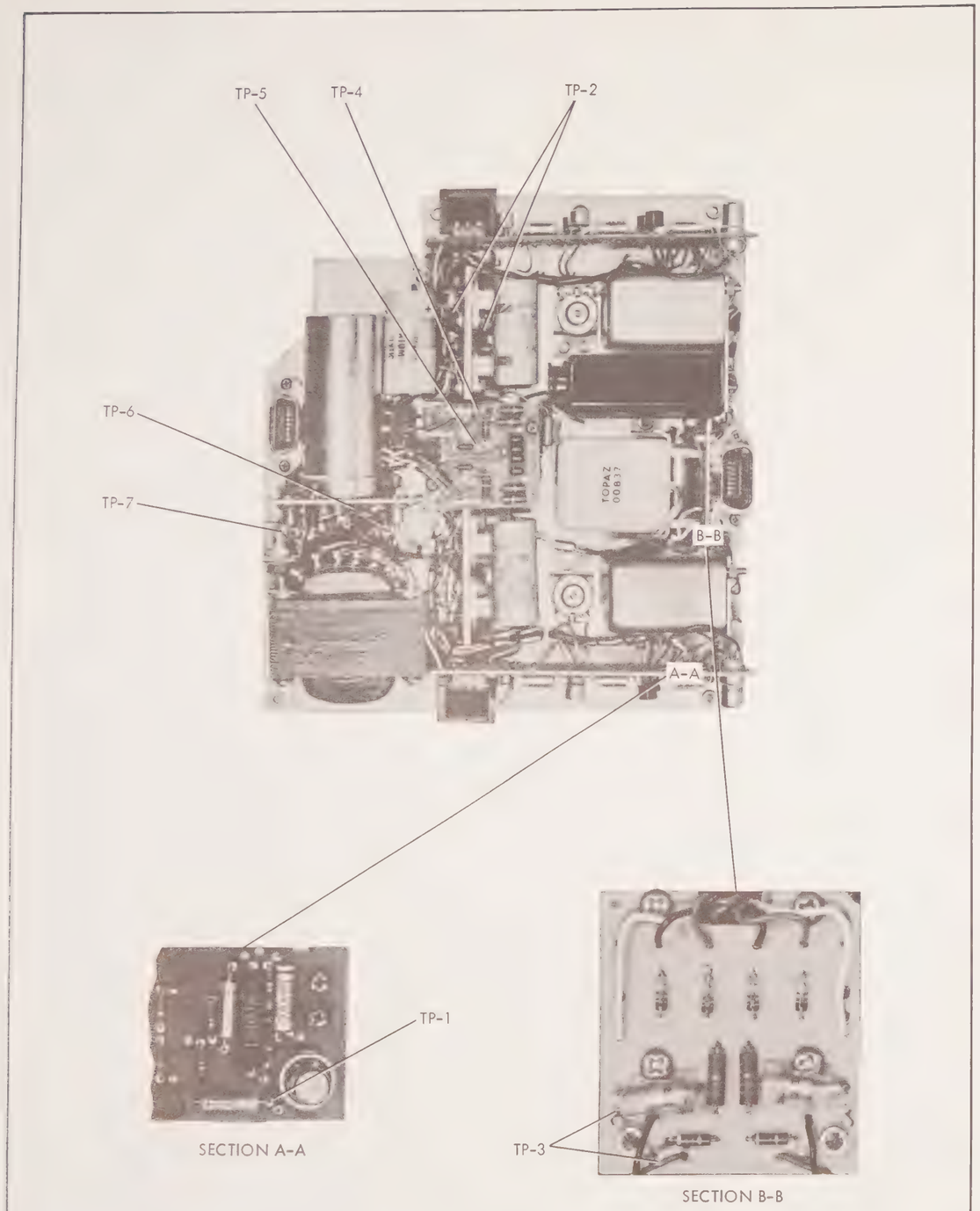



FIGURE 5-11. TEST POINT LOCATIONS



## WAVEFORM NOTES

The waveforms on the schematics were taken with a Hewlett-Packard Model 130C oscilloscope, of a 135 series recorder of known quality. Test points may be made accessible by removing the platen. See Figure 5-11 for physical location.

To obtain error signal for TP-1 and TP-2:

a. Manually move pen 1/2 of one sub division (1/20", 1.27 mm).

b. Note error signal on scope.

c. Using zero control suppres zero (set zero beyond graph limits) for same amplitude signal). This allows a constant error signal without manually holding pen off null.

## TEST POINTS

TP-1 Photo (a) is take at null; (b) is at 0.5% full scale off null.

TP-2 Same as TP-1.

TP-3 Make measurements (with servo at null) across diode, i.e.; the (+) probe is connected to one side of the diode, the (-) probe to the other.

TP-4 Servo at null.

TP-5 Servo at null.

TP-6 Servo at null.

TP-7 Servo at null.

### OSCILLOSCOPE SETTINGS

1. 5 ms/cm sweep speed.
2. Attenuator probe NOT used.
3. Observe scope polarity, negative side is connected to chassis ground.
4. All measurements except those taken at TP-3 are referenced to ground.

### RECORDER SETTINGS

1. Recorder must be grounded.
2. Short input terminals.
3. Recorder must be in normal operating position, i.e., flat on table or horizontal in rack. Do not set on side as the weight of the carriage beam will cause an error signal.
4. Set the gain to 70% (mechanical) of its adjustable range.

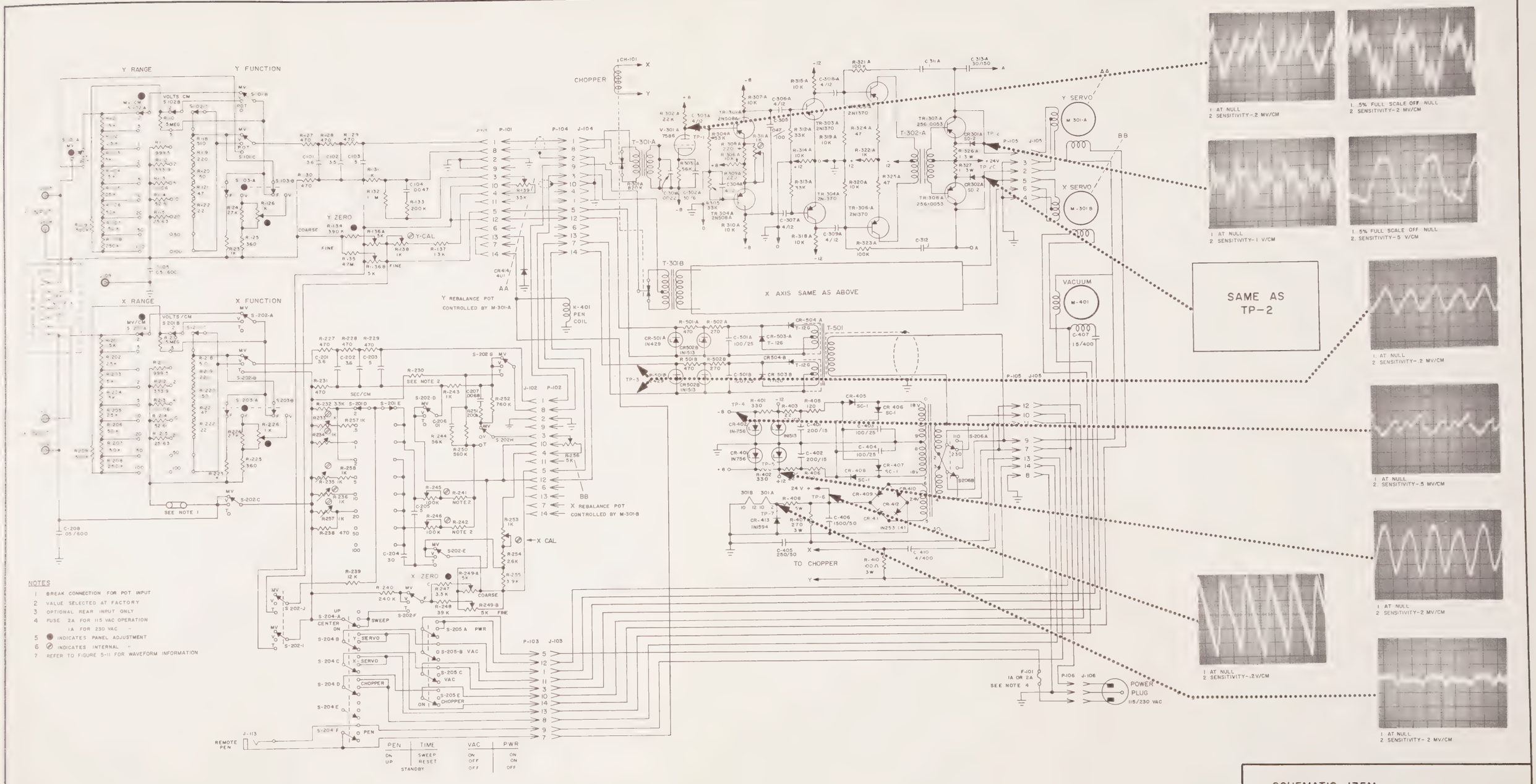
NOTE:

1. BREAK CONNECTION FOR POT INPUT
2. VALUE SELECTED AT FACTORY
3. OPTIONAL REAR INPUT ONLY
4. FUSE: 2A FOR 115 VAC OPERATION
   1A FOR 230 VAC ,,
5. ● INDICATES PANEL ADJUSTMENT
6. ⊘ INDICATES INTERNAL ,,
7. REFER TO FIGURE 5-11 FOR WAVEFORM INFORMATION

SCHEMATIC 135
MODEL: S/N 504 & UP

D-9836

FIGURE 5-12. SCHEMATICS (135)




SCHEMATIC 135M
MODEL: S/N 504 & UP

D-12491

FIGURE 5-13. SCHEMATICS (135M)

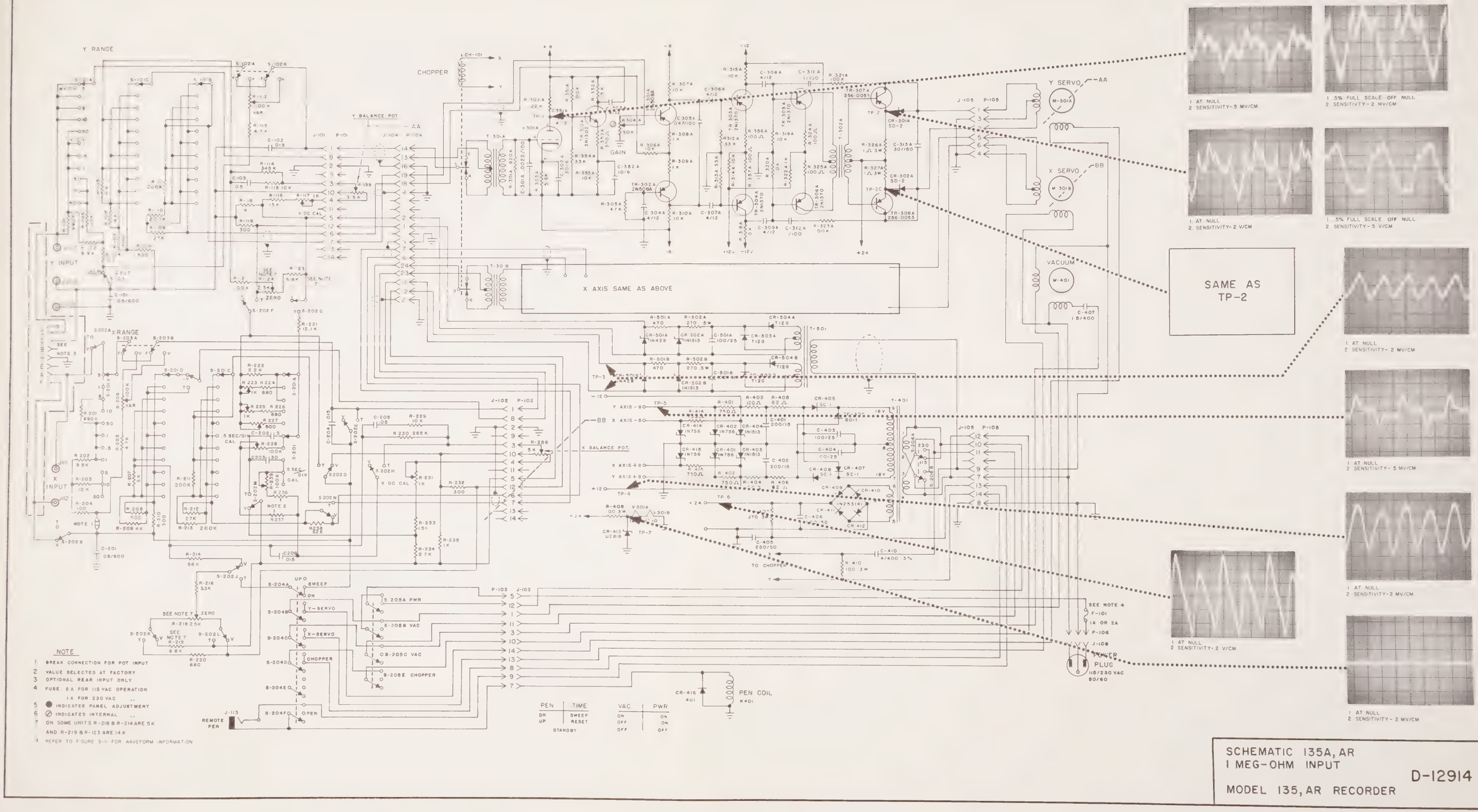



FIGURE 5-14. SCHEMATICS (135A)

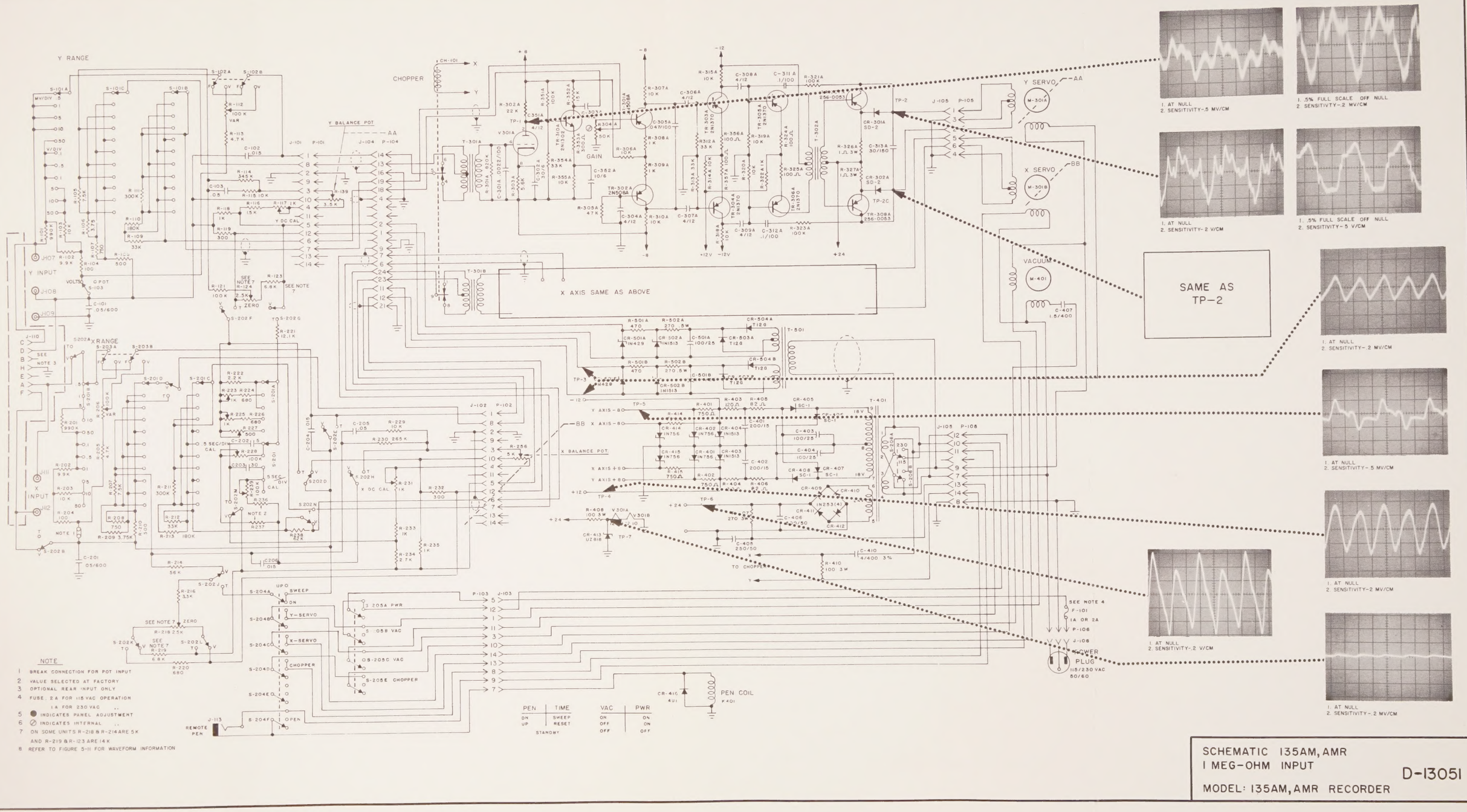



FIGURE 5-15. SCHEMATICS (135AM)

## WARRANTY

F. L. Moseley Co. warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year after delivery to the original purchaser. Liability under this warranty is limited to servicing, adjusting, or the replacement of defective parts, (other than tubes, fuses, or batteries) on any machine returned to the factory for this purpose, transportation charges prepaid. Before returning to the factory for any reason, notify us of the difficulty encountered, the model and serial number of the instrument, and we will furnish you with service or shipping instructions.

## SHIPPING

If the instrument is to be returned to the factory for any reason the following precautions should be adhered to:

1. Remove pen or ink cartridge.

2. Secure the carriage beam to one side of the recorder to prevent movement while in transit.

3. If the instrument is being returned for repair do not send power cord and accessory kit.

4. Wrap the instrument in heavy paper or plastic and surround it with three to four inches of shock-absorbing material to cushion it and prevent movement inside the shipping container. The container should be sufficiently durable to prevent damage to instrument during handling.

5. Ship instrument to: Customer Service
   F. L. Moseley Co.
   45 Eureka Street
   Pasadena, California

6. Address correspondence to: Customer Service
   F. L. Moseley Co.
   409 North Fair Oaks Avenue
   Pasadena, California

THE MOSELEY